Ball-Foster
Glass Container Co., L.L.C.
A Saint-Gobain Company

1509 South Macedonia Avenue
Muncie, Indiana 47302-3664

Reply to: P.O. Box 4200
Muncie, Indiana 47307-4200

Tel. 765 741-7000
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May 26, 1999

VIA FAXSIMILE & US MAIL

CONFIDENTIAL – FOR SETTLEMENT PURPOSES ONLY

Mr. Jay M. Willenberg, P.E.
Senior Air Pollution Engineer
Puget Sound Air Pollution Control Agency
110 Union Street, Suite 500
Seattle, Washington 98101-2038

RE: Ball-Foster Glass Container Co., - Seattle, WA
       Title V Permit-PSAPCA Request for Additional Information

Dear Mr. Willenberg:

This letter is to be used along with our previous letters of March 19, 1999 and April 23, 1999 and is intended to respond to your letters dated February 10, 1999, March 11, 1999 and May 4, 1999 with the best reasonably available information. In your letters, the Puget Sound Air Pollution Agency, (PSAPCA), requested additional information in order to complete processing of our Title V permit application. In this letter we will make another attempt to fully address the issues that PSAPCA has raised.

This letter is not intended to respond to the " enforcement action" that is currently pending between the PSAPCA and Ball-Foster. As such, nothing in this letter is to be construed as an admission of liability by Ball-Foster and the PSAPCA is hereby precluded from using any statements in this letter against Ball-Foster in any enforcement action unless the information is obtained from a source independent of this letter.

I.   PROCEDURES AND USAGES IN MOLD SWABBING OPERATIONS

As we have consistently maintained over the years, the mold swabbing operation is a very critical part of our operation and numerous attempts have been made to either use other coatings or to automate the application process. From the emissions perspective, the concern is with the release of the mold swabbing compounds. These compounds are better known as " release agents" (containing a mixture of petroleum hydrocarbons, sulfur and graphite), and when applied to metal glass-forming molds they prevent sticking of the hot glass to the mold. If release agents were not used the sticking of the hot glass to the mold results in defects and rejected bottles.

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The process as it exists today in the container industry, involves a manual technique of applying the swabbing material to the blank (preform) mold, blow mold and the neck ring (the part of the mold, which forms the sealing or capping surface). This swabbing is done from both sides of the I.S. machine The machine operator will use a combination of hand held swabbing tools shaped in the form of small mops, known as finger swabs and mold swabs. To apply the swab compound, the swabs are dipped into a bucket containing the liquid swabbing compound and then rolled to remove any dripping liquid. Then the operator will swab the glass contact surfaces on each machine section after the bottle is formed and released. The material instantly flashes and an oil mist rises above the machine. On average, this entire operation is completed within a couple of minutes. During this process some of the swabbing compound will transfer to the next containers made and this results in rejecting these bottles with losses running as high as 5% or more. Thus, it is to our advantage to extend the time between mold swab cycles as far apart as possible, in order to minimize these bottle losses, improve productivity, and minimize emissions.

On any single day or shop, the start of the mold swab cycle will vary within a range of from approximately 15-30 minutes. This facility uses two (2) swabbing compounds identified as Kleenmold 170 and Kleenmold 197. During 1998 the usage of KM170 was 36,620 lbs. and KM 197 was 21,140 lbs. The Material Safety Data Sheets (MSDS) provided in our letter of April 23, 1999 indicates that these compounds are _not_ volatile organic compounds (VOC's). These compounds have a very low vapor pressure and a flash point exceeding 300 degrees F. In our calculation of emissions in Attachment 1, we assumed that 50% of the hydrocarbons are released to the atmosphere above the machines immediately after the mold is swabbed. Ball-Foster believes that this is a good conservative engineering estimate based on the fact that high volumes of turbulent air used in cooling the machine, causes the oil mist which is generated after flashing, to swirl and spread in all directions. These emissions of particulate matter become fugitive emissions and Ball-Foster is not aware of any method to quantify these emissions with any adequate degree of accuracy.

Toxic Air Contaminants. Prior to 1999, the mention of air toxics as related to mold swabbing compounds was never raised as an issue of concern. Indeed, an analysis of the MSDS does not indicate any listed toxic component as a major ingredient. In reviewing the MSDS section, Thermal Decomposition Products, the manufacturer indicates that the fumes could possibly contain carbon monoxide, oxides of sulfur and various polyaromatic hydrocarbons which may result from the incomplete combustion of all

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petroleum hydrocarbon products. Ball-Foster has not conducted any testing of fugitive emissions from our mold swabbing process. However, Ball-Foster has conducted personal hygiene monitoring of our forming operators and the latest results indicate that two (2) contaminants as listed in Appendix A, Regulation III were identified and measured. These contaminants are:

Contaminant	Exposure Conc.	OSHA Limit
Oil Mist, mineral	0.230 mg/m3	5.0 mg/m3
Formaldehyde	0.02 ppm	0.75 ppm

[handwritten margin note: Jot indicative of bldg emissions - hours less accum. in bldg]

These results were the average of several personal monitoring samples, time weighted average exposures over a 7 hour period taken on the I.S. machine operators.

II   COMPLIANCE PLAN

As Ball-Foster stated in our previous two letters dated March 19, 1999 and April 23, 1999, it appears that at least one of the items you requested, namely, a "compliance plan" requests information that is related to a pending enforcement action. It is Ball-Foster's position that a " compliance plan" is not required to be submitted as part of its Title V permit application, when the facility is in compliance. Despite Ball-Foster's view that a "compliance plan" is related to the enforcement action, Ball-Foster believes that the information relating to the "parameters" that may be measured, as set forth in Section III., infra, will address that issue and give the PSAPCA the comfort level they need to ensure that Ball-Foster will be in continual compliance with the terms and conditions governing the operation of its facility.

[handwritten margin note: Why do they link this? AC 173-401-510(h)]

III.   EVALUATION OF FURNACE OPERATING PARAMETERS

The district requested in a letter of 2/10/99 an analysis of source test results conducted since June 1995. All test data, including some of the statistical analysis results, are summarized in the attached six tables. Copies of the data summaries from individual test reports are also enclosed. These test reports were previously submitted to PSAPCA. The summary includes data from earlier tests since there was not sufficient data from 1995-98 to complete the statistical analysis requested. Furnace operating variables included are

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Pull Rate (tons glass/day), furnace temperature (bridgewall), percent cullet in the batch, natural gas (cu ft/hr) and electric boost (kwh/hr), which are the major variables affecting particulate emissions. Furnaces #2, #3 and #5 are oxy-fuel fired and #4 is a conventional air-gas regenerative furnace. Furnace #3 was converted to oxy-fuel in early 1993 and #2 and #5 furnaces were converted to oxy-fuel in early 1994, which limits the history on these furnaces. The glasses melted are all conventional soda-lime-silica container compositions with colorant additives. Glass properties such as density, refractive index, hardness, color and others are strictly a function of glass composition which is constant. Furnace pressure, O_2/fuel or air/fuel ratio is set for maximum combustion efficiency and is also constant. Flow rates and velocities of combustion gases are dependant on gas usage and furnace design and are constant for a given production rate. A checklist used to review furnace operations is found in Attachment 11. An analysis of pull rate, temperature, opacity, grain loading and other variables is included in a later section on predictive modeling. The particulate species emitted from a glass container furnace is predominately ($\geq$ 95%) sodium sulfate (see attached analysis of particulate collected by an electrostatic precipitator) formed by volatilization of sodium oxide and sulfur from the glass at furnace operating temperatures of about 2750 °F. This has been shown by qualitative analysis of material collected from other tests on glass furnaces over many years. Since the amount of material collected during a standard Method 5 test is so small (50-100 mg.), it is not possible to do quantitative analysis for many other species.

Of the 22 tests conducted on the four Seattle furnaces since 6/95, nearly all have demonstrated compliance with permit limits. On two occasions, the measured emissions from #5 furnace would have been in compliance with the limit as changed by PSAPCA in 10/98 (the original limit was too low based on other test results). Number 2 furnace is the largest of the Seattle furnaces and has the lowest particulate emission limit of 3.0 lb./hr (0.36 lb./ton at 200 tons/day), the lowest of any Ball-Foster uncontrolled furnace in the company. Tests in 8/96 and 11/98 showed particulate emissions over the 3.0 lb./hr limit with grain loading over the allowable of 0.05 gr./dscf on the South stack only. It was found that the furnace firing condition was such that the temperature was higher on one side causing higher particulate emissions from that stack. The other (North) stack was within limits. Following the 8/96 test, the test firm was asked to check the samples for possible contamination and none was found, however, a low pH on the back half was cause for an analysis of sulfuric acid hydrate, which contributed to part of the high result on the South stack. A test in 6/95 was slightly over the lb./hr limit but grain loading was well within limits. No operating problems were noted during this test.

[handwritten margin notes: "how was this determined? show data or reference" "how does "color" relate to "cullet"" "what caused this?"]

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Before discussing the predictive modeling and related questions in the 5/4/99 PSAPCA letter, some comments are in order. A limited number of tests results makes an extensive analysis of variables difficult, and statistical analysis, of questionable validity if too few variables are considered. The most recently published works we have seen for predicting particulate emissions from glass melting furnaces was published in 1978 and is a compilation of several regenerative furnaces. These analyses did not include as many variables as we will show (only pull rate, temperature and furnace size) and were done to predict particulate emissions in pounds/hour. We have included natural gas, electric boost and cullet, which can affect temperature, another major variable. Ball-Foster investigated the opacity-grain loading relationship. However, our analysis was focused on the calculation of mass emissions and grain loading, which showed much better correlations. Therefore, we feel this is a more valid approach for predicting grain loading than opacity.

It is also accepted in the glass industry that any analysis of variables for a given furnace operation is only valid over the normal range of production and is found to be nearly linear. Obviously, emissions are not zero at a zero production rate since the furnace is still at operating temperature. For this reason, the NSPS for glass furnaces has an allowance for particulate of 0.5 lb./hr at furnace idle conditions. Also, remember that for a given statistical analysis, the number of tests must be at two more than the number of independent variables in order to calculate an intercept. We have thus included tests earlier than 6/95 to allow for inclusion of a greater number of major variables.

In this analysis, PSAPCA has asked for a study of emission mechanisms and variables which, to date, has not been done in the glass industry. Data is lacking to the extent that there will be a proposal to DOE (Department of Energy) from GMIC (Glass Manufacturers Industry Council) to commit research funding to basic studies of parameters affecting particulate and other emissions from glass melting furnaces with the goal of developing predictive emission models. These models could then be used to help operate furnaces in a manner to minimize emissions and improve performance. With this as background, the following describes our analysis of existing data in regard to particulate emissions based on:

1. Opacity - grain loading relationships
2. Mass emissions as a function of currently measured major parameters

No data was used which was not included in earlier test reports.

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Opacity - Grain Loading

In the letter from PSAPCA dated 5/4/99, a number of questions were asked relating to our earlier draft example, which was submitted in our letter dated April 23, 1999. Our response is as follows to your questions concerning, the interpretation of opacity and grain loading data, including the use of percent opacity rather than optical density, front-half/back half effects, dry standard instead of actual volumes and forcing the results though the origin. Since the regulatory limit is in gr./dscf and percent opacity is measured by transmissometers, this is the most logical relationship to pursue initially, and one PSAPCA has advocated for many years. Conversely, the glass industry, including Ball-Foster, has maintained that this relationship does not provide a good correlation, which is shown by the existing data. Converting to absorbance does not improve the correlation. We have also looked at front-half/back-half ratios, and have found them to be constant at 5-10% back half. Since the back half is not expected to affect opacity (since it is not a particulate in the stack) and the limit for grain loading is based on total of both front and back half, we have used total grain loading consistently. An examination of grain loading based on both standard and actual conditions shows no improvement in correlation under actual conditions of measurement. In practice, we could only estimate conversions from standard to actual grain loading from stack temperature and estimated moisture content based on previous tests. Correlations using log, power and exponential relationships showed no better results than a linear relation. Results were not forced through zero grain loading since we have tests, which measured zero opacity, using data from properly calibrated and operating transmissometers. The statistical analysis of opacity and absorbance as a function of grain loading (both dry and actual) is shown on the attached graphs. Note that R^2 is less than about 0.5 for all stacks except #2 furnace South, which was 0.7 for grain loading vs. %opacity. As you know, R^2 is a measure of how well the dependent and independent variable are correlated, and can have a value of between zero and one. A value of 0.5, means that 50% of the variance in the dependent variable is explained by the independent variable. When grain loading was investigated as a function of the furnace operating variables already mentioned, R^2 improved to a range of about 0.6 on #3 to 0.95 on #5. Usually we would expect a value of R^2 of at least 0.9 for a valid predictive equation.

Any relationship assumes characteristics about particles, such as size, shape, size distribution and absorbance or reflectivity. There are likely contributions to this lack of correlation which are currently not known or understood. This is an area that, to our

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knowledge, has not been researched in a theoretical or analytical way for glass furnace emissions, as noted earlier.

Mass Emissions as a Function of Furnace Operating Parameters

Since the opacity-grain loading correlations were found to be a generally poor predictor of actual conditions, a multiple regression analysis approach was conducted for the effect of major furnace operating parameters on particulate mass emissions. As noted earlier, the particulate species emitted from a glass container furnace is predominately sodium sulfate formed by volatilization of sodium oxide and sulfur from the glass at furnace operating temperatures of about 2750 °F. The rate of volatilization depends on several factors: production rate (tons of glass melted per hour), furnace temperature (higher temperatures $\approx$ higher emissions), percent cullet in the batch (higher cullet = lower batch sulfate), natural gas usage (generally higher gas = higher temperature) and electric boost (energy directly into glass). As noted earlier, other parameters such as furnace pressure, batch wetting, glass density and glass composition are constants. Also, as previously mentioned, emissions are not zero at idle and the production rate on a given furnace is determined by the jobs being run. To conduct a statistical analysis of the effect of five independent variables requires seven sets of data in order to calculate a Y-intercept. This required going beyond the District request for data analysis since 6/95 because there would only have been sufficient data to look at three or four variables. Data from these tests, shown in the tables, was all submitted to PSAPCA as part of the compliance test reports. The range of each parameter is representative of normal operation and over this range, a multiple linear regression analysis provides a good prediction of particulate emissions as shown in the attached graphs. Results are presented from the multiple regression analysis of five independent variables (pull rate, temperature, cullet, gas, boost) and one dependent variable (PM in lb./hr). The analysis yields a constant or Y-intercept, standard error of Y estimate (similar to standard deviation), R^2 (square of correlation coefficient; 1.0 = one-to-one correspondence), coefficients for each independent variable and the standard error of each coefficient. In the resulting equation, the product of each variable and its' coefficient is summed with the other variables and added to the Y-intercept to give the predicted emission. For example,

$$(Pull * C_P) + (BW\ temp * C_T) + (\%\ Cullet * C_C) + (Gas * C_G) + (Boost * C_B) + (Y\text{-}intercept) = PM\ (lb./hr)$$

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A calculated emission ± the standard error of Y for a given set of independent variables would cover 67% of the actual data. An R^2 of 0.9 means that 90% of the variance in the dependent variable is accounted for by the independent variables used. An R^2 of >0.9 is considered very good. In practice, the predicted value of particulate will be subject to some correction for the standard error, that is, the true value could be greater or less than the predicted value. The range for the predicted value should be at least ± one standard error, so that the above equation becomes

$$(\text{Pull} * C_P) + (\text{BW temp} * C_T) + (\% \text{ Cullet} * C_C) + (\text{Gas} * C_G) + (\text{Boost} * C_B) + (\text{Y-intercept}) \pm (\text{Std. Err}) = \text{PM (lb/hr)}$$

Values of R^2 range from 0.8 for #2 and #5 to 0.99 for #3 furnace. Since the data cover a relatively small range of operating variables where linear regression is valid and particulate emissions are not zero when production is not zero, the Y-intercept can be positive or negative. The fact that some of the X-coefficients (independent variables) are positive for some furnaces and negative for others reflects the statistical analysis procedure and the way in which each furnace is operated to produce quality glass.

Since there is no reason to expect that additional data would improve the correlations, no further tests are planned, other than the periodic testing required to demonstrate compliance with our permit.

After you have had on opportunity to review this letter and the attachments, Ball-Foster would like to suggest that we could be available to meet for a conference at your office at the earliest mutually available date. Please call me at 765-741-7116 with a suggested date for our consideration.

Sincerely

John R. Mino
Senior Environmental Engineer

JRM

Attachments

ATTACHMENTS LIST

1. Calculation of Mold Swabbing Emissions

2. MSDS for Kleenmold 170

3. MSDS for Kleenmold 197

4. Glass Furnace – Particulate Emission Analysis

5. Emission Data – Furnaces 2,3,4,5

6. Emission Data – Furnaces 2,3,4,5

7. Emission Data – Furnaces 2,3,4,5

8. Emission Data – Furnaces 2,3,4,5

9. Emission Data – Furnaces 2,3,4,5

10. Emission Data – Furnace #2

11. Check List for Compliance

12 thru 15. Regression Analysis – Particulate Emissions Furnaces 2,3,4,5

16 thru 19. Regression Analysis – Grain Loading – Furnaces 2,3,4,5

20 thru 29. Particulate vs Opacity & Absorbance – Furnaces 2,3,4,5

30 thru 41. Emission Summary Results – February 1992 thru January 1999.

B

Ball-Foster Glass Container Co., L.L.C.

Seattle, Washington

Mold Swabbing Operation – Attachment 1

Seattle has five (5) furnaces with **each furnace having two (2) Eight Section Bottle Making Machines.** Ball-Foster has not been required to monitor or record mold swabbing compound usage by furnace. Therefore, we have made the assumption that since each machine has the same number of sections, each furnace will use the same amount of swabbing material.

Annual usage of mold swabbing compounds for 1998 is 57,760 lbs.   *28.88 tons*

Annual usage <u>per</u> furnace is 57,760 / 5 = 11,552 lbs.

Daily usage <u>per</u> furnace is 11,552 / 365 = 31.6 lbs.

Hourly usage <u>per</u> furnace is 11,552 / 8760 = 1.31 lbs.

Assume 75 percent of the swabbing compound is petroleum based lubricating oils, which will volatilize at temperatures greater than 800 degrees F and is being released inside the building as **fugitive** emissions.

Emissions released from the molds are visible and are in the form of TSP (soot and tars) = 1.31 x 0.75 = 0.982 lbs./hr

Assume 50% of emissions is released through the ventilator into the atmosphere.

Net emissions = 0.982 lbs./hr x 0.5 = 0.491 lbs./hr.

Annual Emissions of TSP = 0.491 x 8760 = 4,301 lbs. Or 2.15 tons/yr./furnace

MATERIAL SAFETY DATA SHEET

SPECIALTY PRODUCTS COMPANY
75 Montgomery Street
Jersey City, New Jersey 07302

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

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PRODUCT NAME........................: Kleenmold 170
PRODUCT CODE........................: G0105008
CHEMICAL FAMILY.....................: Petroleum Hydrocarbons
FORMULA.............................: Petroleum oil/graphite/sulfur
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SUPPLIER: EMERGENCY TELEPHONE NUMBERS:
Specialty Products Company   201-434-4700

2. COMPOSITION/INFORMATION ON INGREDIENTS:
HAZARDOUS INGREDIENTS

INGREDIENT NAME /CAS NUMBER	EXPOSURE LIMITS	CONCENTRATION
Petroleum-based severely hydrotreated Lubricating Oil CAS # 64742-52-5	TLV 5 mg/m^3 (as an oil mist)	
Fatty Acids, Tallow, Calcium Salts CAS # 64755-01-7	N/E	
Sulfurized Fatty Oil Esters CAS # 68153-71-9	N/E	
Graphite in Petroleum Oil Additive CAS # N/A	N/E	
Sulfur CAS # 7704-34-9	PEL 15 mg/m^3 (as a dust)	

3. HAZARDOUS IDENTIFICATION

HMIS RATING
Health: 1 Flammability: 1 Reactivity: 0 Protection: See Section 8

NFPA RATING
Health: 1 Flammability: 1 Reactivity: 0

EXPOSURE LIMIT FOR TOTAL PRODUCT: 5 mg/cubic meter for oil mist in
air, based on OSHA Regulation 29 CFR 1910.1000

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EMERGENCY OVERVIEW

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<u>POTENTIAL HEALTH EFFECTS</u>: Health studies have shown that many petroleum hydrocarbons and synthetic lubricants pose potential human health risks which vary from person to person. As a precaution, exposure to liquids, vapors, mists, or fumes should be minimized.

ROUTES OF ENTRY: Possibly skin and inhalation.

<u>HUMAN EFFECTS AND SYMPTOMS OF OVEREXPOSURE</u>: This product is judged to be neither a "corrosive" nor an "irritant" by OSHA criteria.

INHALATION: Possible aspiration hazard. Swallowing or induced or spontaneous vomiting may cause product to enter the lungs. (See First Aid Measures in Section 4)

SKIN CONTACT: Prolonged or repeated skin contact with this product tends to remove skin oils possibly leading to irritation and dermatitis.

EYE CONTACT: Product contacting the eye may cause irritation.

INGESTION: No information available from supplier.

CARCINOGENICITY: This product does NOT contain any ingredients identified as carcinogenic by IARC, NTP, or OSHA.
NTP: None
IARC: None
OSHA: None

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Unknown.

4. <u>FIRST AID MEASURES</u>

FIRST AID FOR EYES: In case of eye contact, flush with plenty of clear water for at least 15 minutes or until irritation subsides. If irritation persists, call a physician.

FIRST AID FOR SKIN: If on skin, remove contaminated clothing and wash skin thoroughly with soap and water.

FIRST AID FOR INHALATION: If overcome by vapor or smoke from hot product, immediately remove from exposure and call a physician. If breathing is irregular or has stopped, start resuscitation, administer oxygen if available. If overexposure to oil mist, remove from further exposure until excessive oil mist condition subsides.

FIRST AID FOR INGESTION: If swallowed, do not induce vomiting. Give water to drink. Call a physician immediately. Never give anything by mouth to an unconscious person.

5. **FIRE FIGHTING MEASURES:**

FLASH POINT: 320°F (160°C) COC

FLAMMABLE OR EXPLOSIVE LIMITS (approximate percent by volume in air): Estimated values: lower 1%   upper 6%

EXTINGUISHING MEDIA AND FIRE FIGHTING PROCEDURES: Use water spray, dry chemical, foam, or carbon dioxide. A solid stream of water or foam may cause frothing. Use water to keep fire-exposed containers cool. Use self-contained breathing apparatus (pressure demand MSHA/NIOSH approved or equivalent) and full fire fighting turn out gear in fighting fires near or involving the product. Thoroughly decontaminate fire fighting equipment after use.

UNUSUAL FIRE AND EXPLOSION HAZARDS: N/A

6. **ACCIDENTAL RELEASE MEASURES:**

SPILL OR LEAK PROCEDURES: Keep product out of sewers and watercourses by diking or impounding. Absorb with sand or inert material. Sweep or scoop up and remove. Prevent spread of spill. Advise authorities if product has entered or may enter sewers, watercourses or extensive land areas. Assure conformity with federal, state and local regulations.

7. **HANDLING AND STORAGE:**

HANDLING AND STORAGE PRECAUTIONS: Minimize breathing vapor, mist, or fumes. Avoid prolonged or repeated contact with skin. Remove contaminated clothing, launder before reuse. Remove contaminated shoes and thoroughly clean before reuse; destroy if oil-soaked. Cleanse skin thoroughly after contact, before breaks and meals, and at end of work period. Product is readily removed from skin by waterless hand cleaners followed by washing thoroughly with soap and water. Keep containers closed when not in use. Do not handle near heat, sparks, flame, or strong oxidants.

KLEENMOLD 170
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SHELF LIFE: Indefinite, provided material is kept sealed in original container away from extreme heat.

SPECIAL SENSITIVITY: Strong oxidants and extreme heat exposure.

8. **EXPOSURE CONTROLS/PERSONAL PROTECTION:**

EYE PROTECTION REQUIREMENTS: Use splash goggles or face shield or safety glasses with side shields when eye contact may occur.

SKIN PROTECTION REQUIREMENTS: Use chemical-resistant apron or other impervious clothing, if needed, to avoid contaminating regular clothing which could result in prolonged or repeated skin contact. The use of gloves is recommended to avoid prolonged or repeated skin contact.

RESPIRATORY/VENTILATION REQUIREMENTS:

RESPIRATORY PROTECTION: Avoid breathing vapor, mist or fumes of decomposition products. Wear NIOSH/MSHA approved respiratory protection equipment when airborne exposure limits may be exceeded. Use filter, dust, fume or mist respirator type under misting conditions. Use can or cartridge gas or vapor respirator type under conditions exceeding TWA standard.

VENTILATION: (Always maintain below permissible exposure limits) Use local exhaust to capture vapor, mist or fumes, if necessary. Provide ventilation sufficient to prevent exceeding recommended exposure limit or buildup of explosive concentrations of vapor in air.

9. **PHYSICAL AND CHEMICAL PROPERTIES:**

PHYSICAL FORM:	Liquid
COLOR:	Black
ODOR:	Petroleum
BOILING POINT:	Wide range
MELT POINT/FREEZE POINT:	Not applicable
PH:	Not applicable
SOLUBILITY IN WATER:	Negligible
SPECIFIC GRAVITY:	0.87
BULK DENSITY:	7.3
% VOLATILE BY WEIGHT:	Nil
VAPOR PRESSURE:	< 0.1 @ 100°F (38°C)
VAPOR DENSITY:	>8 (AIR = 1)

10. **REACTIVITY:**

STABILITY: This product is stable and will NOT react violently with water.

CONDITIONS TO AVOID: Open flame, extreme heat.

HAZARDOUS POLYMERIZATION: Will not occur.

INCOMPATIBILITIES: Avoid contact with strong oxidants such as liquid chlorine, concentrated oxygen, sodium hypochlorite or calcium hypochlorite, etc. as this presents a serious explosion hazard.

THERMAL DECOMPOSITION PRODUCTS: Precise decomposition product analysis is unknown. Proper ventilation will reduce the smoke and fumes that could possibly include carbon monoxide, oxides of sulfur and various polyaromatic hydrocarbons which may result from the incomplete combustion of all petroleum hydrocarbon products.

11. **TOXICOLOGICAL INFORMATION:**

ORAL (Acute)	N/E
DERMAL (Acute)	N/E
EYE	N/E
INHALATION (Acute)	N/E
CHRONIC, SUBCHRONIC, ETC.	N/E

12. **ECOLOGICAL INFORMATION:** Avoid product from entering sewers, watercourses or extensive land areas.

13. **DISPOSAL CONSIDERATIONS:**

WASTE DISPOSAL METHOD: (Consult federal, state, or local authorities for proper disposal procedures) Assure conformity with applicable disposal regulations. Dispose of absorbed material at an approved waste site or facility.

EMPTY CONTAINER WARNING: Empty containers retain residue (liquid or vapor) and can be dangerous. DO NOT PRESSURIZE, WELD, CUT, BRAZE, SOLDER, DRILL, GRIND OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, OR OTHER SOURCES OF IGNITION; THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Do not attempt to clean since residue is difficult to remove. "Empty" drums should be completely drained, properly bunged, and returned to a drum reconditioner.

KLEENMOLD 170
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14. <u>TRANSPORTATION INFORMATION</u>: This product is not regulated by DOT.

   D.O.T. SHIPPING NAME: Compound or lubricant NOI
   TECHNICAL SHIPPING NAME: None
   D.O.T. HAZARD CLASS: None
   U.N./N.A. NUMBER: None
   D.O.T. LABEL: None
   OTHER INFORMATION: None

15. <u>REGULATORY INFORMATION</u>: SARA section 313: This material is not known
   to contain any chemicals on the SARA Section 313 list at a
   concentration greater than 1.0% or carcinogenic chemical on that list
   at a concentration greater than 0.1%

16. <u>OTHER INFORMATION</u>: Toxic Substance Control Act (TSCA): all
   components in this material are included in the TSCA inventory.

   PREPARED BY: Raul D. Hernandez
   DATE: May/1994

TO THE BEST OF OUR KNOWLEDGE, THE INFORMATION CONTAINED HEREIN IS ACCURATE.
HOWEVER, SPECIALTY PRODUCTS COMPANY ASSUMES NO LIABILITY WHATSOEVER FOR THE
ACCURACY OR COMPLETENESS OF THE INFORMATION CONTAINED HEREIN. FINAL
DETERMINATION OF SUITABILITY OF ANY MATERIAL IS THE SOLE RESPONSIBILITY OF
   USER. ALL MATERIALS MAY PRESENT UNKNOWN HEALTH HAZARDS AND SHOULD BE
   D WITH CAUTION. ALTHOUGH CERTAIN HAZARDS ARE DESCRIBED HEREIN, WE
CANNOT GUARANTEE THAT THESE ARE THE ONLY HAZARDS WHICH EXIST.

MATERIAL SAFETY DATA SHEET

SPECIALTY PRODUCTS COMPANY
75 Montgomery Street
Jersey City, New Jersey   07302

1.   CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME.........................: Kleenmold 197
PRODUCT CODE........................: G0105012
CHEMICAL FAMILY.....................: Petroleum Hydrocarbons
FORMULA.............................: Petroleum oil/graphite/sulfur

SUPPLIER: ~   EMERGENCY TELEPHONE NUMBERS:
Specialty Products Company   201-434-4700

2.   COMPOSITION/INFORMATION ON INGREDIENTS:
HAZARDOUS INGREDIENTS

INGREDIENT NAME /CAS NUMBER	EXPOSURE LIMITS	CONCENTRATION
Petroleum-based severely hydrotreated Lubricating Oil CAS # 64742-52-5	TLV 5 mg/m^3 (as an oil mist)	
...ty Acids, Tallow, Calcium Salts CAS # 64755-01-7	N/E	
Sulfurized Fatty Oil Esters CAS # 68153-71-9	N/E	
Graphite in Petroleum Oil Additive CAS # N/A	N/E	
Sulfur CAS # 7704-34-9	PEL 15 mg/m^3 (as a dust)	

3.   HAZARDOUS IDENTIFICATION

HMIS RATING
Health: 1 Flammability: 1 Reactivity: 0 Protection: See Section 8

NFPA RATING
Health: 1 Flammability: 1 Reactivity: 0

EXPOSURE LIMIT FOR TOTAL PRODUCT: 5 mg/cubic meter for oil mist in
air, based on OSHA Regulation 29 CFR 1910.1000

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EMERGENCY OVERVIEW

****

POTENTIAL HEALTH EFFECTS: Health studies have shown that many petroleum hydrocarbons and synthetic lubricants pose potential human health risks which vary from person to person. As a precaution, exposure to liquids, vapors, mists, or fumes should be minimized.

ROUTES OF ENTRY: Possibly skin and inhalation.

HUMAN EFFECTS AND SYMPTOMS OF OVEREXPOSURE: This product is judged to be neither a "corrosive" nor an "irritant" by OSHA criteria.

INHALATION: Possible aspiration hazard. Swallowing or induced or spontaneous vomiting may cause product to enter the lungs. (See First Aid Measures in Section 4)

SKIN CONTACT: Prolonged or repeated skin contact with this product tends to remove skin oils possibly leading to irritation and dermatitis.

EYE CONTACT: Product contacting the eye may cause irritation.

INGESTION: No information available from supplier.

CARCINOGENICITY: This product does NOT contain any ingredients identified as carcinogenic by IARC, NTP, or OSHA.
   NTP: None
   IARC: None
   OSHA: None

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Unknown.

FIRST AID MEASURES

FIRST AID FOR EYES: In case of eye contact, flush with plenty of clear water for at least 15 minutes or until irritation subsides. If irritation persists, call a physician.

FIRST AID FOR SKIN: If on skin, remove contaminated clothing and wash skin thoroughly with soap and water.

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FIRST AID FOR INHALATION: If overcome by vapor or smoke from hot product, immediately remove from exposure and call a physician. If breathing is irregular or has stopped, start resuscitation, administer oxygen if available. If overexposure to oil mist, remove from further exposure until excessive oil mist condition subsides.

FIRST AID FOR INGESTION: If swallowed, do not induce vomiting. Give water to drink. Call a physician immediately. Never give anything by mouth to an unconscious person.

5. **FIRE FIGHTING MEASURES:**

FLASH POINT: 320°F (160°C) COC

FLAMMABLE OR EXPLOSIVE LIMITS (approximate percent by volume in air): Estimated values: lower 1% upper 6%

EXTINGUISHING MEDIA AND FIRE FIGHTING PROCEDURES: Use water spray, dry chemical, foam, or carbon dioxide. A solid stream of water or foam may cause frothing. Use water to keep fire-exposed containers cool. Use self-contained breathing apparatus (pressure demand MSHA/NIOSH approved or equivalent) and full fire fighting turn out gear in fighting fires near or involving the product. Thoroughly decontaminate fire fighting equipment after use.

UNUSUAL FIRE AND EXPLOSION HAZARDS: N/A

6. **ACCIDENTAL RELEASE MEASURES:**

SPILL OR LEAK PROCEDURES: Keep product out of sewers and watercourses by diking or impounding. Absorb with sand or inert material. Sweep or scoop up and remove. Prevent spread of spill. Advise authorities if product has entered or may enter sewers, watercourses or extensive land areas. Assure conformity with federal, state and local regulations.

7. **HANDLING AND STORAGE:**

HANDLING AND STORAGE PRECAUTIONS: Minimize breathing vapor, mist, or fumes. Avoid prolonged or repeated contact with skin. Remove contaminated clothing, launder before reuse. Remove contaminated shoes and thoroughly clean before reuse; destroy if oil-soaked. Cleanse skin thoroughly after contact, before breaks and meals, and at end of work period. Product is readily removed from skin by waterless hand cleaners followed by washing thoroughly with soap and water. Keep containers closed when not in use. Do not handle near heat, sparks, flame, or strong oxidants.

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SHELF LIFE: Indefinite, provided material is kept sealed in original container away from extreme heat.

SPECIAL SENSITIVITY: Strong oxidants and extreme heat exposure.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION:

EYE PROTECTION REQUIREMENTS: Use splash goggles or face shield or safety glasses with side shields when eye contact may occur.

SKIN PROTECTION REQUIREMENTS: Use chemical-resistant apron or other impervious clothing, if needed, to avoid contaminating regular clothing which could result in prolonged or repeated skin contact. The use of gloves is recommended to avoid prolonged or repeated skin contact.

RESPIRATORY/VENTILATION REQUIREMENTS:

RESPIRATORY PROTECTION: Avoid breathing vapor, mist or fumes of decomposition products. Wear NIOSH/MSHA approved respiratory protection equipment when airborne exposure limits may be exceeded. Use filter, dust, fume or mist respirator type under misting conditions. Use can or cartridge gas or vapor respirator type under conditions exceeding TWA standard.

VENTILATION: (Always maintain below permissible exposure limits) Use local exhaust to capture vapor, mist or fumes, if necessary. Provide ventilation sufficient to prevent exceeding recommended exposure limit or buildup of explosive concentrations of vapor in air.

9. PHYSICAL AND CHEMICAL PROPERTIES:

PHYSICAL FORM:	Liquid
COLOR:	Black
ODOR:	Petroleum
BOILING POINT:	Wide range
MELT POINT/FREEZE POINT:	Not applicable
PH:	Not applicable
SOLUBILITY IN WATER:	Negligible
SPECIFIC GRAVITY:	0.87
BULK DENSITY:	7.3
% VOLATILE BY WEIGHT:	Nil
VAPOR PRESSURE:	< 0.1 @ 100°F (38°C)
VAPOR DENSITY:	>8 (AIR = 1)

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REACTIVITY:

STABILITY: This product is stable and will NOT react violently with water.

CONDITIONS TO AVOID: Open flame, extreme heat.

HAZARDOUS POLYMERIZATION: Will not occur.

INCOMPATIBILITIES: Avoid contact with strong oxidants such as liquid chlorine, concentrated oxygen, sodium hypochlorite or calcium hypochlorite, etc. as this presents a serious explosion hazard.

THERMAL DECOMPOSITION PRODUCTS: Precise decomposition product analysis is unknown. Proper ventilation will reduce the smoke and fumes that could possibly include carbon monoxide, oxides of sulfur and various polyaromatic hydrocarbons which may result from the incomplete combustion of all petroleum hydrocarbon products.

1. **TOXICOLOGICAL INFORMATION:**

ORAL (Acute)	N/E
DERMAL (Acute)	N/E
EYE	N/E
INHALATION (Acute)	N/E
CHRONIC, SUBCHRONIC, ETC.	N/E

.2. **ECOLOGICAL INFORMATION:** Avoid product from entering sewers, watercourses or extensive land areas.

L3. **DISPOSAL CONSIDERATIONS:**

WASTE DISPOSAL METHOD: (Consult federal, state, or local authorities for proper disposal procedures) Assure conformity with applicable disposal regulations. Dispose of absorbed material at an approved waste site or facility.

EMPTY CONTAINER WARNING: Empty containers retain residue (liquid or vapor) and can be dangerous. DO NOT PRESSURIZE, WELD, CUT, BRAZE, SOLDER, DRILL, GRIND OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, OR OTHER SOURCES OF IGNITION; THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Do not attempt to clean since residue is difficult to remove. "Empty" drums should be completely drained, properly bunged, and returned to a drum reconditioner.

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TRANSPORTATION INFORMATION: This product is not regulated by DOT.

D.O.T. SHIPPING NAME:	Compound or lubricant NOI
TECHNICAL SHIPPING NAME:	None
D.O.T. HAZARD CLASS:	None
U.N./N.A. NUMBER:	None
D.O.T. LABEL:	None
OTHER INFORMATION:	None

REGULATORY INFORMATION: SARA section 313:   This material is not known to contain any chemicals on the SARA Section 313 list at a concentration greater than 1.0% or carcinogenic chemical on that list at a concentration greater than 0.1%

OTHER INFORMATION: Toxic Substance Control Act (TSCA):   all components in this material are included in the TSCA inventory.

PREPARED BY:	Raul D. Hernandez
DATE:	May/1994

Weck
Laboratories

ATTACHMENT 4

Client: Ball-Foster Glass Container Corporation
4000 North Arden Drive
El Monte, CA   91734-1238

Report Date: November 20, 1997

Received Date: October 28, 1997
Tuesday 13:35/MVR

Attn.: Sandy Nakano

(818) 448-9831 x   FAX (818) 279-3225

Project Name: **Project #:**
Purchase Order #:   Normal Turnaround

Certificate of Analysis

Lab#: 9723976 **Sample ID:** Electostic Precepitator Dust **Matrix:** Solids
Sampled By: Client **Date:** 10/28/1997 **Time:** 11:00

Parameter	Result	Units	PQL	Method	Analyzed	Run #
Semi-Quantitative ICP Metal Scan........	See Attached			ICP	11/04/1997	97144631
Water Leachable Sulfate.................	481,000	mg/Kg	100000	EPA 300.0	10/30/1997	97144575
Sodium..................................	353,000	mg/Kg	500	EPA 6010	11/18/1997	97145053

ND = Not Detected
PQL = Practical Quantifiable Limit
  e = Estimated (> MDL, but < PQL)

_____
Authorized Signature

Any remaining sample(s) for testing will be disposed of three weeks from the final report
date unless other arrangements are made in advance.

Glass furnace - particulate emission analysis

Sodium (Na) × 1.348 = Na_2O

35.3% Na × 1.348 = 47.6% Na_2O

Sulfate = 48.1% (SO_4)

Sodium Sulfate = 47.6% Na_2O + 48.1% SO_4

Sodium Sulfate = 95.7% of particulate

Ball-Foster Furnace Emission Data - Seattle Plant

lb/T

Furnace	Test Date	Furnace Type	Pull T/D	Cullet %	Boost KWH/hr	Nat Gas CFH	BW F	Color	Particulate Matter gr/dscf	lb/hr	
Seattle #2	5/17/94	OF	144.6	39.0	0	23710	2655	F	0.028	2.63	.44
	6/13/95	OF	178.9	27.0	1896	21500	2696	DLG	0.039	3.57	.48
NOV	8/27/96	OF	201.1	14.0	1920	27667	2744	DLG	0.066	5.75	.69 > .5
	1/22/97	OF	190.2	37.0	1775	25083	2745	DLG	0.028	2.79	.35
	7/18/97	OF	191.6	20.0	1935	25583	2740	DLG	0.026	2.28	.29
NOV	11/18/98	OF	200.9	18.9	1904	26792	2735	DLG	0.061	5.29	.63
	1/14/99	OF	203.5	22.6	1883	27333	2728	AT	0.031	2.63	.31
Seattle #3	3/24/93	OF	172.4	29.0	1196	22314	2714	DLG	0.041	3.61	.71
	3/24/94	OF	186.0	6.0	1333	24000	2735	DLG	0.034	6.39	.82
	5/18/94	OF	166.8	22.0	1250	21450	2705	DLG	0.022	4.15	.60
	6/14/95	OF	201.7	22.0	1650	26666	2738	DLG	0.034	6.07	.72
	8/28/96	OF	183.2	21.0	1450	23625	2733	AT	0.024	4.55	.60
	7/17/97	OF	201.7	28.3	1454	28708	2750	DLG	0.036	5.44	.65
	11/11/98	OF	192.9	34.1	1471	25083	2741	DLG	0.022	4.30	.53
Seattle #4	2/6/92	OF EP	127.9	40.0	2100	24500	2625	DLG	0.027	8.02	1.50
	3/23/93	EP	121.7	61.0	1278	21623	2600	A	0.015	3.49	0.69
	5/19/94	EP	131.3	47.0	0	20800	2710	A	0.039	7.18	1.31
NOV	6/16/95	EP	123.4	60.0	1360	16000	2742	EG	0.027	3.31	.64 > .5 #/T
	8/29/96	EP	138.7	71.0	1321	20583	2805	A	0.029	4.17	.72
	7/15/97	EP	140.9	28.5	1487	19292	2810	A	0.040	4.62	.79
	11/19/98	EP	141.9	44.7	1480	20583	2822	F	0.026	3.93	.66
Seattle #5	3/25/94	OF	149.6	49.0	0	21300	2735	F	0.020	2.10	.34
	5/20/94	OF	130.7	45.0	0	19860	2714	F	0.024	2.69	.49
	6/15/95	OF	134.5	45.0	1435	12690	2699	DLG	0.009	1.34	.24
	8/30/96	OF	138.1	64.0	1290	16042	2766	EG	0.020	2.76	.48
NOV	7/16/97	OF	151.2	32.6	1361	21250	2725	F	0.023	3.47	> 2.8 lb/hr .5
NOV	1/13/98	OF	160.7	66.0	1256	20250	2725	F	0.026	3.48	.55 #/T > .5
	4/15/98	OF	186.9	52.6	1436	18230	2749	CH	0.015	2.77	> .52
	11/12/98	OF	186.5	41.7	1352	24250	2765	CH	0.026	3.17	> .36

> .41

OF - Oxy-Fuel

EP - End Port Regenerative

404 CF/min

05/28/99

Ball-Foster Furnace Emission Data - Seattle Plant

Furnace	Test Date	N % Opacity	S % Opacity	N Absorbance	S Absorbance	Stack DSCFM	ACFM	Temp	%O2	%H2O	%CO2
Seattle #2	5/17/94					11061	22784	531	19.1	8.8	5.8
	6/13/95					10759	22611	563	19.4	8.4	5.4
NOV	8/27/96	10.21	5.53	0.04677	0.02471	10140	25797	727	18.7	10.8	9.3
	1/22/97	5.64	2.29	0.02521	0.01006	10325	23522	634	19.0	9.0	6.5
	7/18/97	5.35	2.94	0.02388	0.01296	10311	21104	538	19.8	8.5	5.7
NOV.	11/18/98	7.35	3.72	0.03315	0.01646	10207	23992	649	17.2	10.0	7.7
	1/14/99	7.73	3.79	0.03494	0.01678	9909	22834	623	19.2	10.6	7.5
Seattle #3	3/24/93					23253	35682	314	20.1	4.6	3.3
	3/24/94					22009	35586	351	19.7	5.5	4.3
	5/18/94	4.70		0.02091		21633	33743	324	20.3	5.3	2.3
	6/14/95					21149	39993	475	19.4	6.3	3.7
	8/28/96	3.20		0.01412		22168	38574	413	20.1	5.9	3.4
	7/17/97	5.60		0.02503		17311	35847	551	19.5	8.1	3.7
	11/11/98	0.50		0.00218		22489	36771	358	19.6	6.0	3.8
Seattle #4	2/6/92					28170	53842	502	18.1	4.4	2.2
	3/23/93	6.50		0.02919		26610	48182	452	17.7	4.5	2.3
	5/19/94	1.70		0.00745		21355	36465	393	16.9	5.4	2.6
NOV	6/16/95					14093	25307	428	17.4	6.2	2.4
	8/29/96	0.50		0.00218		17013	32154	474	15.9	6.9	3.4
	7/15/97	0.00		0.00000		13576	25411	462	14.5	7.5	4.3
	11/19/98	0.10		0.00043		17823	33629	451	16.0	6.5	3.9
Seattle #5	3/25/94					12085	21383	414	19.8	7.2	4.4
	5/20/94	6.00		0.02687		12183	22168	432	19.5	7.4	5.4
	6/15/95					17647	26418	294	20.5	4.3	1.8
	8/30/96	0.60		0.00261		16438	26523	346	20.1	6.0	3.1
NOV	7/16/97	4.40		0.01954		17473	31034	429	20.2	5.9	1.9
NOV	1/13/98					15714	28466	427	20.2	6.6	2.1
	4/15/98	6.70		0.03012		21221	32135	308	20.0	4.7	2.3
	11/12/98	6.83		0.03072		14492	25365	403	19.5	7.1	4.4

05/28/99

Ball-Foster Furnace Emission Data - Seattle Plant

		Particulate Matter									
		Particulate Matter Coefficients						Calc PM		Calc+	Calc-
	Test	Pull	Cullet	Boost	Nat Gas						
Furnace	Date	T/D	%	KWH/hr	CFH	BW F	Y-Intercept	lb/hr	Std Err	Std Err	Std Err
Seattle #2	5/17/94	0.984776	-0.481871	-0.031548	-0.005761	0.198858	-512.32	2.65	1.569668	4.223	1.084
	6/13/95	0.984776	-0.481871	-0.031548	-0.005761	0.198858	-512.32	3.28	1.569668	4.853	1.714
	8/27/96	0.984776	-0.481871	-0.031548	-0.005761	0.198858	-512.32	4.67	1.569668	6.238	3.099
	1/22/97	0.984776	-0.481871	-0.031548	-0.005761	0.198858	-512.32	2.51	1.569668	4.081	0.942
	7/18/97	0.984776	-0.481871	-0.031548	-0.005761	0.198858	-512.32	3.16	1.569668	4.729	1.590
	11/18/98	0.984776	-0.481871	-0.031548	-0.005761	0.198858	-512.32	5.87	1.569668	7.436	4.297
	1/14/99	0.984776	-0.481871	-0.031548	-0.005761	0.198858	-512.32	2.80	1.569668	4.367	1.228
Seattle #3	3/24/93	0.099748	-0.089999	-0.001151	0.000035	-0.034030	82.11	3.74	0.238090	3.981	3.505
	3/24/94	0.099748	-0.089999	-0.001151	0.000035	-0.034030	82.11	6.36	0.238090	6.595	6.119
	5/18/94	0.099748	-0.089999	-0.001151	0.000035	-0.034030	82.11	4.03	0.238090	4.267	3.790
	6/14/95	0.099748	-0.089999	-0.001151	0.000035	-0.034030	82.11	6.11	0.238090	6.348	5.872
	8/28/96	0.099748	-0.089999	-0.001151	0.000035	-0.034030	82.11	4.65	0.238090	4.886	4.410
	7/17/97	0.099748	-0.089999	-0.001151	0.000035	-0.034030	82.11	5.43	0.238090	5.670	5.194
	11/11/98	0.099748	-0.089999	-0.001151	0.000035	-0.034030	82.11	4.19	0.238090	4.429	3.953
Seattle #4	2/6/92	-0.895518	-0.117705	-0.001584	0.002089	0.089466	-155.71	7.74	1.475616	9.213	6.262
	3/23/93	-0.895518	-0.117705	-0.001584	0.002089	0.089466	-155.71	3.87	1.475616	5.350	2.398
	5/19/94	-0.895518	-0.117705	-0.001584	0.002089	0.089466	-155.71	7.07	1.475616	8.547	5.596
	6/16/95	-0.895518	-0.117705	-0.001584	0.002089	0.089466	-155.71	3.30	1.475616	4.774	1.823
	8/29/96	-0.895518	-0.117705	-0.001584	0.002089	0.089466	-155.71	3.57	1.475616	5.049	2.098
	7/15/97	-0.895518	-0.117705	-0.001584	0.002089	0.089466	-155.71	4.09	1.475616	5.569	2.618
	11/19/98	-0.895518	-0.117705	-0.001584	0.002089	0.089466	-155.71	5.07	1.475616	6.548	3.597
Seattle #5	3/25/94	-0.015700	0.024191	0.000846	0.000253	-0.002033	3.79	2.45	0.616162	3.070	1.838
	5/20/94	-0.015700	0.024191	0.000846	0.000253	-0.002033	3.79	2.33	0.616162	2.948	1.716
	6/15/95	-0.015700	0.024191	0.000846	0.000253	-0.002033	3.79	1.70	0.616162	2.320	1.088
	8/30/96	-0.015700	0.024191	0.000846	0.000253	-0.002033	3.79	2.70	0.616162	3.312	2.080
	7/16/97	-0.015700	0.024191	0.000846	0.000253	-0.002033	3.79	3.19	0.616162	3.808	2.576
	1/13/98	-0.015700	0.024191	0.000846	0.000253	-0.002033	3.79	3.51	0.616162	4.125	2.893
	4/15/98	-0.015700	0.024191	0.000846	0.000253	-0.002033	3.79	2.37	0.616162	2.982	1.750
	11/12/98	-0.015700	0.024191	0.000846	0.000253	-0.002033	3.79	3.53	0.616162	4.144	2.912

05/28/99

Ball-Foster Furnace Emission Data - Seattle Plant

		Grain Loading									
		Grain Loading (DSCF) Coefficients						Calc		Calc+	Calc-
	Test	Pull	Cullet	Boost	Nat Gas						
Furnace	Date	T/D	%	KWH/hr	CFH	BW F	Y-Intercept	GR/DSCF	Std Err	Std Err	Std Err
Seattle #2	5/17/94	0.010955	-0.005502	-0.000349	-0.000063	0.002143	-5.530758	0.028	0.016915	0.045	0.011
	6/13/95	0.010955	-0.005502	-0.000349	-0.000063	0.002143	-5.530758	0.036	0.016915	0.053	0.019
	8/27/96	0.010955	-0.005502	-0.000349	-0.000063	0.002143	-5.530758	0.054	0.016915	0.071	0.038
	1/22/97	0.010955	-0.005502	-0.000349	-0.000063	0.002143	-5.530758	0.025	0.016915	0.042	0.008
	7/18/97	0.010955	-0.005502	-0.000349	-0.000063	0.002143	-5.530758	0.036	0.016915	0.052	0.019
	11/18/98	0.010955	-0.005502	-0.000349	-0.000063	0.002143	-5.530758	0.067	0.016915	0.084	0.050
	1/14/99	0.010955	-0.005502	-0.000349	-0.000063	0.002143	-5.530758	0.033	0.016915	0.050	0.016
Seattle #3	3/24/93	0.002028	-0.000160	-0.000087	-0.000001	-0.000792	1.966458	0.035	0.011343	0.046	0.023
	3/24/94	0.002028	-0.000160	-0.000087	-0.000001	-0.000792	1.966458	0.036	0.011343	0.047	0.024
	5/18/94	0.002028	-0.000160	-0.000087	-0.000001	-0.000792	1.966458	0.028	0.011343	0.039	0.016
	6/14/95	0.002028	-0.000160	-0.000087	-0.000001	-0.000792	1.966458	0.032	0.011343	0.043	0.021
	8/28/96	0.002028	-0.000160	-0.000087	-0.000001	-0.000792	1.966458	0.019	0.011343	0.031	0.008
	7/17/97	0.002028	-0.000160	-0.000087	-0.000001	-0.000792	1.966458	0.036	0.011343	0.048	0.025
	11/11/98	0.002028	-0.000160	-0.000087	-0.000001	-0.000792	1.966458	0.027	0.011343	0.039	0.016
Seattle #4	2/6/92	-0.001579	-0.000448	-0.000007	0.000003	0.000205	-0.351331	0.025	0.010226	0.035	0.015
	3/23/93	-0.001579	-0.000448	-0.000007	0.000003	0.000205	-0.351331	0.018	0.010226	0.028	0.007
	5/19/94	-0.001579	-0.000448	-0.000007	0.000003	0.000205	-0.351331	0.038	0.010226	0.048	0.028
	6/16/95	-0.001579	-0.000448	-0.000007	0.000003	0.000205	-0.351331	0.027	0.010226	0.037	0.017
	8/29/96	-0.001579	-0.000448	-0.000007	0.000003	0.000205	-0.351331	0.025	0.010226	0.035	0.015
	7/15/97	-0.001579	-0.000448	-0.000007	0.000003	0.000205	-0.351331	0.036	0.010226	0.047	0.026
	11/19/98	-0.001579	-0.000448	-0.000007	0.000003	0.000205	-0.351331	0.034	0.010226	0.044	0.024
Seattle #5	3/25/94	-0.000183	0.000213	0.000004	0.000002	-0.000005	0.004275	0.022	0.002445	0.025	0.020
	5/20/94	-0.000183	0.000213	0.000004	0.000002	-0.000005	0.004275	0.022	0.002445	0.024	0.019
	6/15/95	-0.000183	0.000213	0.000004	0.000002	-0.000005	0.004275	0.010	0.002445	0.012	0.007
	8/30/96	-0.000183	0.000213	0.000004	0.000002	-0.000005	0.004275	0.020	0.002445	0.022	0.017
	7/16/97	-0.000183	0.000213	0.000004	0.000002	-0.000005	0.004275	0.023	0.002445	0.026	0.021
	1/13/98	-0.000183	0.000213	0.000004	0.000002	-0.000005	0.004275	0.026	0.002445	0.029	0.024
	4/15/98	-0.000183	0.000213	0.000004	0.000002	-0.000005	0.004275	0.014	0.002445	0.017	0.012
	11/12/98	-0.000183	0.000213	0.000004	0.000002	-0.000005	0.004275	0.026	0.002445	0.028	0.023

05/28/99

gr/dscf

Ball-Foster Furnace Emission Data - Seattle Plant

Furnace	Test Date	Particulate Matter gr/dscf	lb/hr	N % Opacity	S % Opacity	N Absorbance	S Absorbance	Stack DSCFM	ACFM	PM gr/acf
Seattle #2	8/27/96	0.066	5.75	.041 10.21	.097 5.53	0.04677	0.02471	10140	25797	0.026
	1/22/97	0.028	2.79	.024 5.64	.032 2.29	0.02521	0.01006	10325	23522	0.012
	7/18/97	0.026	2.28	.027 5.35	.025 2.94	0.02388	0.01296	10311	21104	0.013
	11/18/98	0.061	5.29	.047 7.35	.075 3.72	0.03315	0.01646	10207	23992	0.026
	1/14/99	0.031	2.63	.030 7.73	.033 3.79	0.03494	0.01678	9909	22834	0.014
Seattle #3	5/18/94	0.022	4.15	4.70		0.02091		21633	33743	0.014
	8/28/96	0.024	4.55	3.20		0.01412		22168	38574	0.014
	7/17/97	0.036	5.44	5.60		0.02503		17311	35847	0.017
	11/11/98	0.022	4.30	0.50		0.00218		22489	36771	0.013
Seattle #4	3/23/93	0.015	3.49	6.50		0.02919		26610	48182	0.008
	5/19/94	0.039	7.18	1.70		0.00745		21355	36465	0.023
	8/29/96	0.029	4.17	0.50		0.00218		17013	32154	0.015
	7/15/97	0.040	4.62	0.00		0.00000		13576	25411	0.021
	11/19/98	0.026	3.93	0.10		0.00043		17823	33629	0.014
Seattle #5	5/20/94	0.024	2.69	6.00		0.02687		12183	22168	0.013
	8/30/96	0.020	2.76	0.60		0.00261		16438	26523	0.012
	7/16/97	0.023	3.47	4.40		0.01954		17473	31034	0.013
	4/15/98	0.015	2.77	6.70		0.03012		21221	32135	0.010
	11/12/98	0.026	3.17	6.83		0.03072		14492	25365	0.015

$$R^2 = 0.84$$

Ball-Foster Furnace Emission Data - Seattle Plant

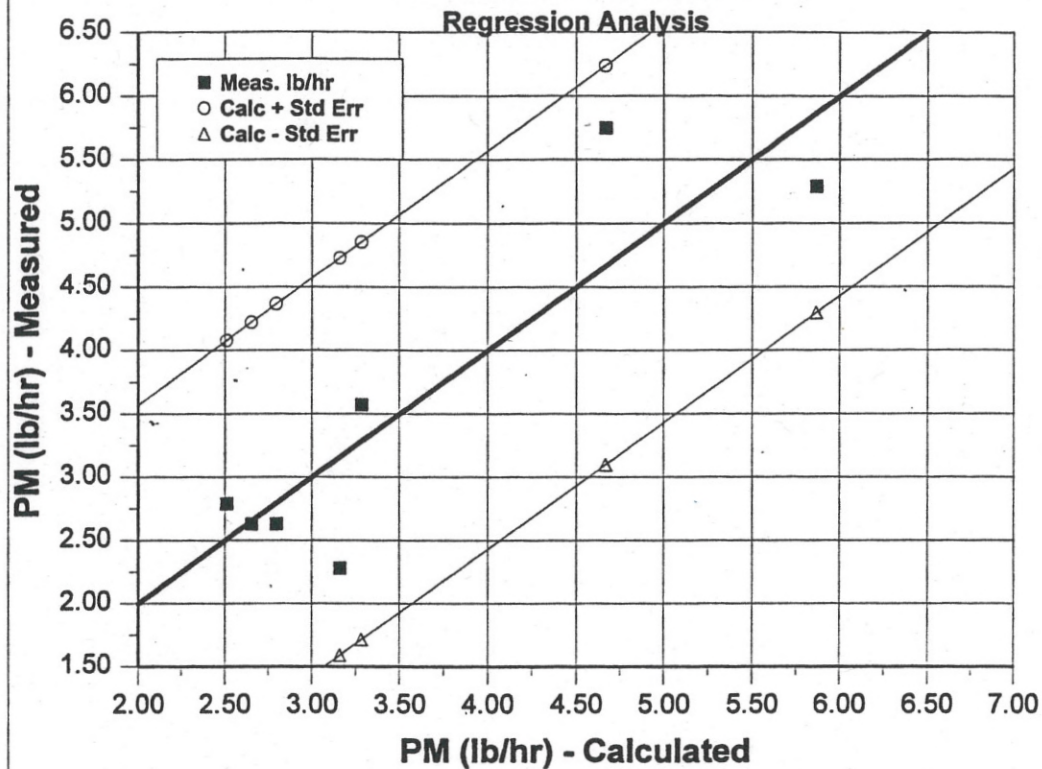| Furnace	Test Date	N % Opacity	S % Opacity	N Absorbance	S Absorbance	North Stack		South Stack		N gr/dscf	S gr/dscf	N gr/acf	S gr/acf
						DSCFM	ACFM	DSCFM	ACFM				
Seattle #2	8/27/96	10.21	5.53	0.04677	0.02471	5591	11326	4549	14471	0.041	0.097	0.020	0.030
	1/22/97	5.64	2.29	0.02521	0.01006	5345	10800	4980	12722	0.024	0.032	0.012	0.013
	7/18/97	5.35	2.94	0.02388	0.01296	5305	10997	5006	10107	0.027	0.025	0.013	0.012
	11/18/98	7.35	3.72	0.03315	0.01646	5178	11210	5029	12782	0.047	0.075	0.022	0.030
	1/14/99	7.73	3.79	0.03494	0.01678	5272	11803	4637	11031	0.030	0.033	0.013	0.014

Check List For Compliance Test
(Review of Standard operating procedures for Furnace operation)

- Inspect burners, clean and adjust as needed

- Check pull rate and set fuel flow rate for optimum melting performance

- Adjust oxygen/fuel or air/fuel ratio for optimum energy performance

- Check reversal time and adjust as required

- Measure oxygen readings and record

- Visually inspect burner flames and adjust for optimum performance

- Check and adjust electric boosting as needed

- Check batch wetting and adjust as required

- Check batch handling and delivery system

- Check percent cullet usage and adjust as needed

- Check and record bridgewall and hot spot temperatures

- Check furnace pressure controls and adjust as required

- Check and adjust furnace damper as required

Seattle #2 Furnace
Particulate Emissions
Regression Analysis

Chart: PM (lb/hr) - Measured vs PM (lb/hr) - Calculated

Legend:
- ■ Meas. lb/hr
- ○ Calc + Std Err
- △ Calc - Std Err

$(Pull * 0.985) + (\%Cullet * -0.482) + (KWH * -0.0315) + (Gas * -0.0058) + (BW * 0.199) + (-512.32) + (+/- 1.57) = PM (lb/hr)$

Seattle #2

Regression Output:

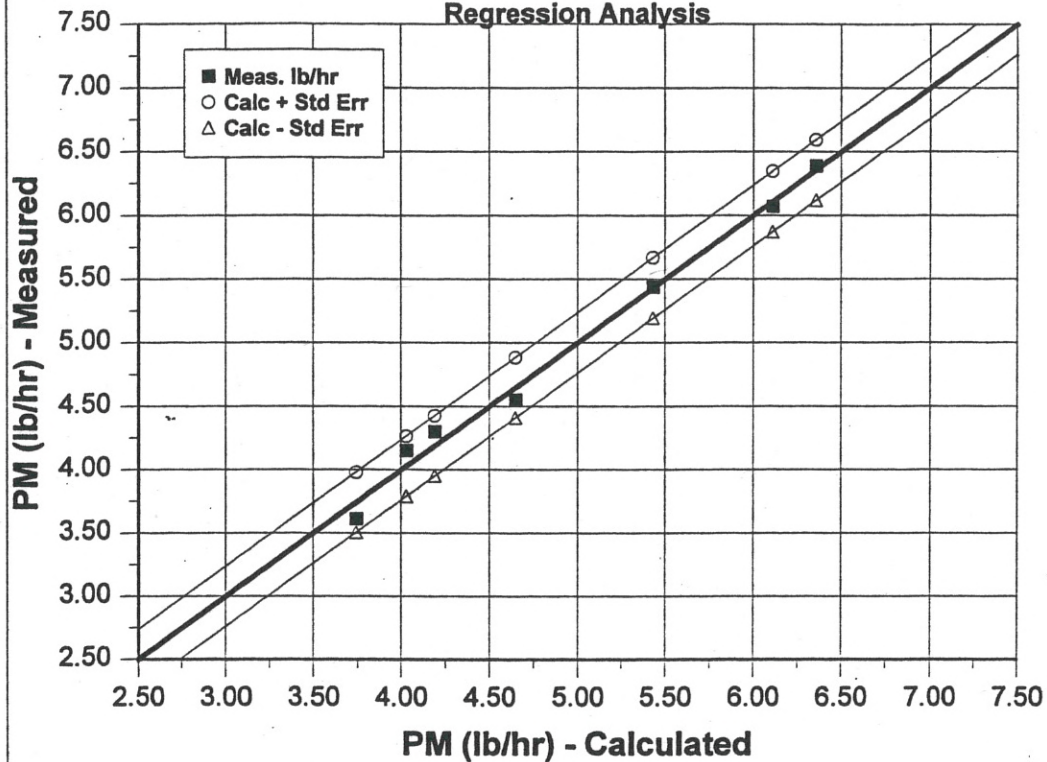|					
Constant		-512.32			
Std Err of Y Est		1.5696677			
R Squared		**0.7903126**			
No. of Observations		7			
Degrees of Freedom		1			

	Pull	% Cullet	KWH/hr	CFH Gas	BW
X Coefficient(s)	0.9847758	-0.481871	-0.031548	-0.005761	0.1988578
Std Err of Coef.	0.7197053	0.2970382	0.0226707	0.0042057	0.1540486

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Seattle #3 Furnace
Particulate Emissions
Regression Analysis

Chart legend:
- ■ Meas. lb/hr
- ○ Calc + Std Err
- △ Calc - Std Err

Y-axis: PM (lb/hr) - Measured
X-axis: PM (lb/hr) - Calculated

(Pull * 0.100) + (%Cullet * -0.090) + (KWH * -0.001) + (Gas * 0.000035) + (BW * -0.034) + (82.11) + (+/- 0.238) = PM (lb/hr)
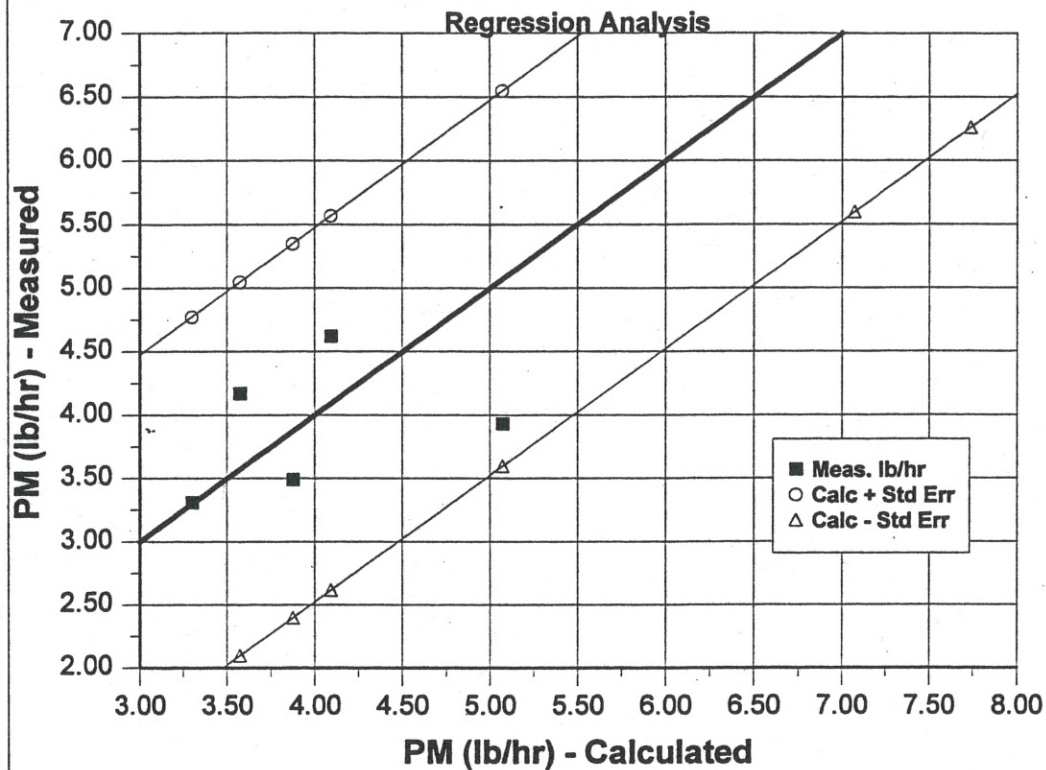
Seattle #3

Regression Output:

Constant		82.106106
Std Err of Y Est		0.2380896
R Squared		**0.9913895**
No. of Observations		7
Degrees of Freedom		1

	Pull	% Cullet	KWH/hr	CFH Gas	BW
X Coefficient(s)	0.099748	-0.089999	-0.001151	0.0000352	-0.03403
Std Err of Coef.	0.0559073	0.0116275	0.0017774	0.0001736	0.0202874

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Seattle #4 Furnace
Particulate Emissions
Regression Analysis

(Pull * -0.896) + (%Cullet * -0.118) + (KWH * -0.0016) + (Gas * 0.0021) + (BW * 0.089) + (-155.71) + (+/- 1.48) = PM (lb/hr)

Seattle #4

Regression Output:

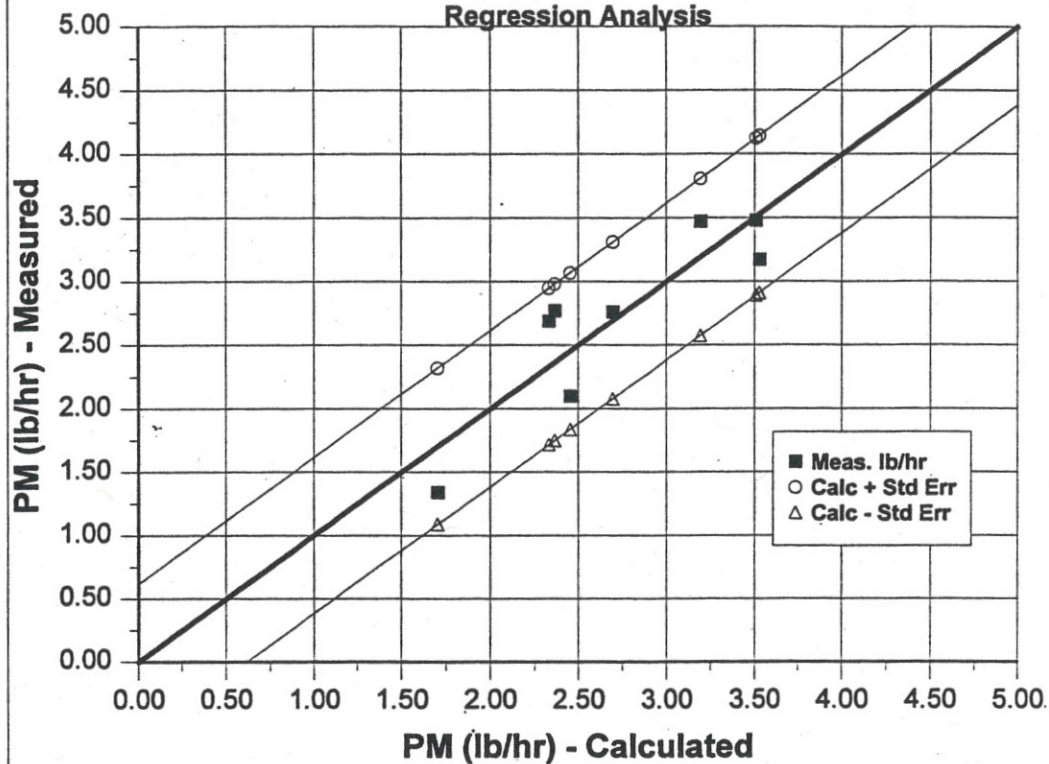|					
Constant		-155.7124			
Std Err of Y Est		1.4756156			
R Squared		**0.8961937**			
No. of Observations		7			
Degrees of Freedom		1			
	Pull	**% Cullet**	**KWH/hr**	**CFH Gas**	**BW**
X Coefficient(s)	-0.895518	-0.117705	-0.001584	0.0020887	0.0894658
Std Err of Coef.	0.5809302	0.0619766	0.0010739	0.0011152	0.060328

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Seattle #5 Furnace
Particulate Emissions
Regression Analysis

(Pull * -0.0157) + (%Cullet * 0.024) + (KWH * 0.00085) + (Gas * 0.00025) + (BW * -0.002) + (3.79) + (+/- 0.62) = PM (lb/hr)
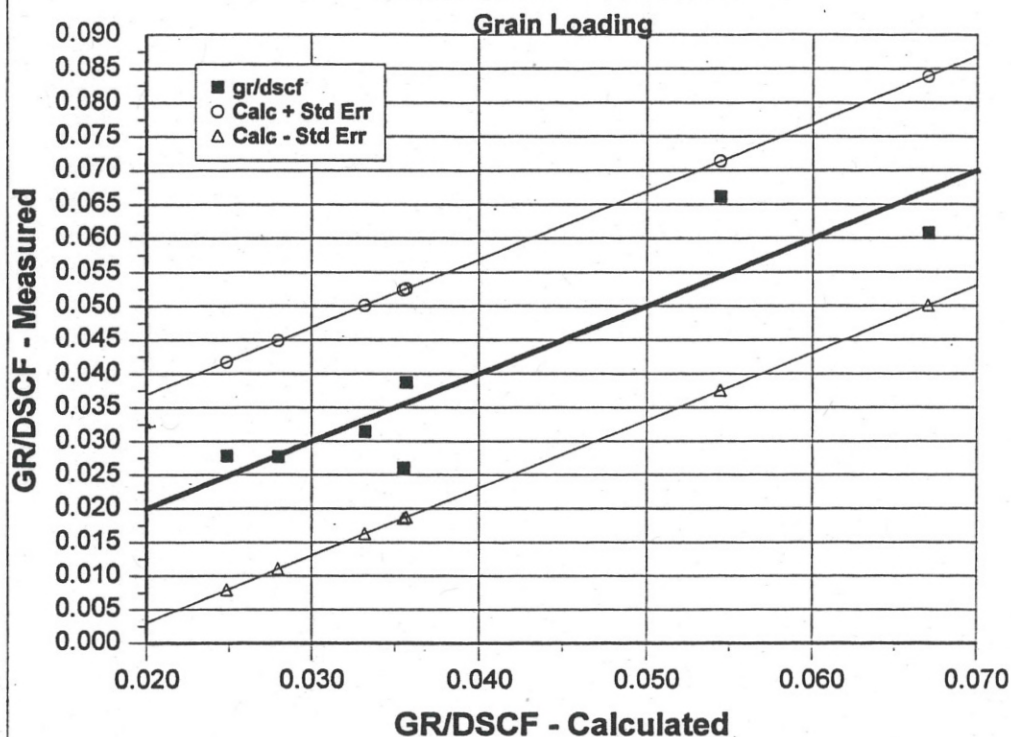
Seattle #5

Regression Output:

Constant		3.7886343			
Std Err of Y Est		0.6161616			
R Squared		**0.7911889**			
No. of Observations		8			
Degrees of Freedom		2			
	Pull	**% Cullet**	**KWH/hr**	**CFH Gas**	**BW**
X Coefficient(s)	-0.0157	0.0241914	0.0008464	0.000253	-0.002033
Std Err of Coef.	0.0178929	0.0246862	0.0005361	0.00011	0.0133527

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Seattle #2 Furnace
Particulate Emissions
Grain Loading

(Pull * 0.011) + (%Cullet * -0.0055) + (KWH * -0.00035) + (Gas * -0.00006) + (BW * 0.0021) + (-5.531) + (+/- 0.017) = GR/DSCF

Seattle #2

Regression Output:

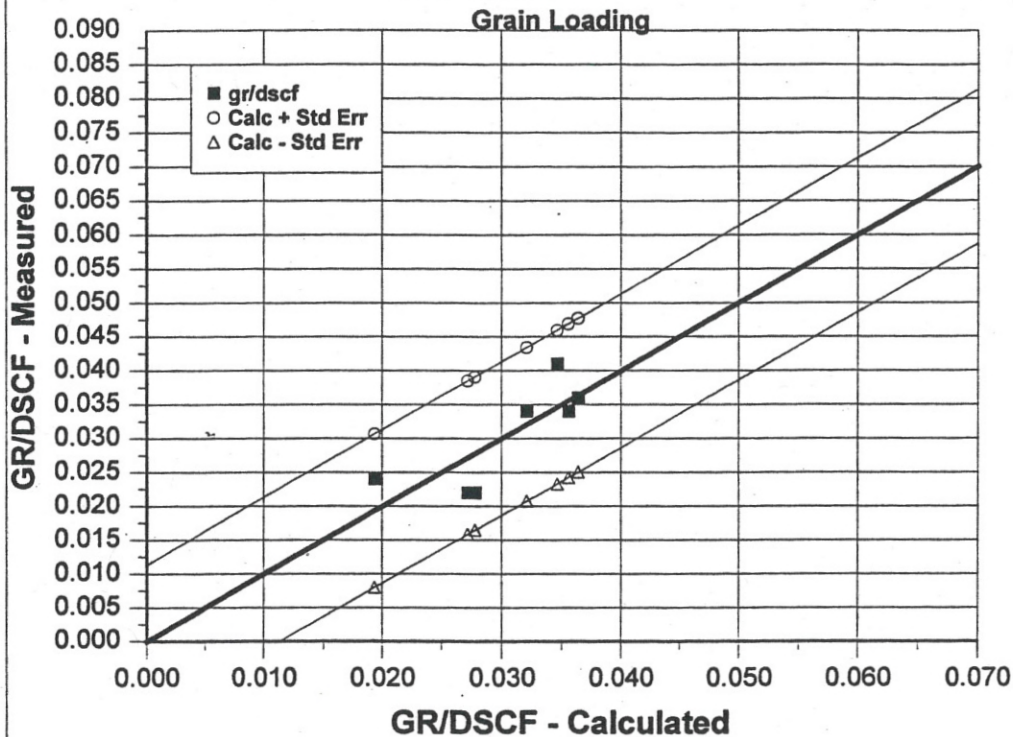|					
Constant	-5.530758				
Std Err of Y Est	0.0169148				
R Squared	0.8300343				
No. of Observations	7				
Degrees of Freedom	1				

	Pull	% Cullet	KWH/hr	CFH Gas	BW
X Coefficient(s)	0.0109554	-0.005502	-0.000349	-0.000063	0.0021432
Std Err of Coef.	0.0077556	0.0032009	0.0002443	0.0000453	0.00166

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Seattle #3 Furnace
Particulate Emissions
Grain Loading

Legend:
- ■ gr/dscf
- ○ Calc + Std Err
- △ Calc - Std Err

Y-axis: GR/DSCF - Measured
X-axis: GR/DSCF - Calculated

(Pull * 0.0020) + (%Cullet * -0.00016) + (KWH * -0.000087) + (Gas * -0.000001) + (BW * -0.00079) + (1.966) + (+/- 0.0113) = GR/DSCF

Seattle #3

Regression Output:
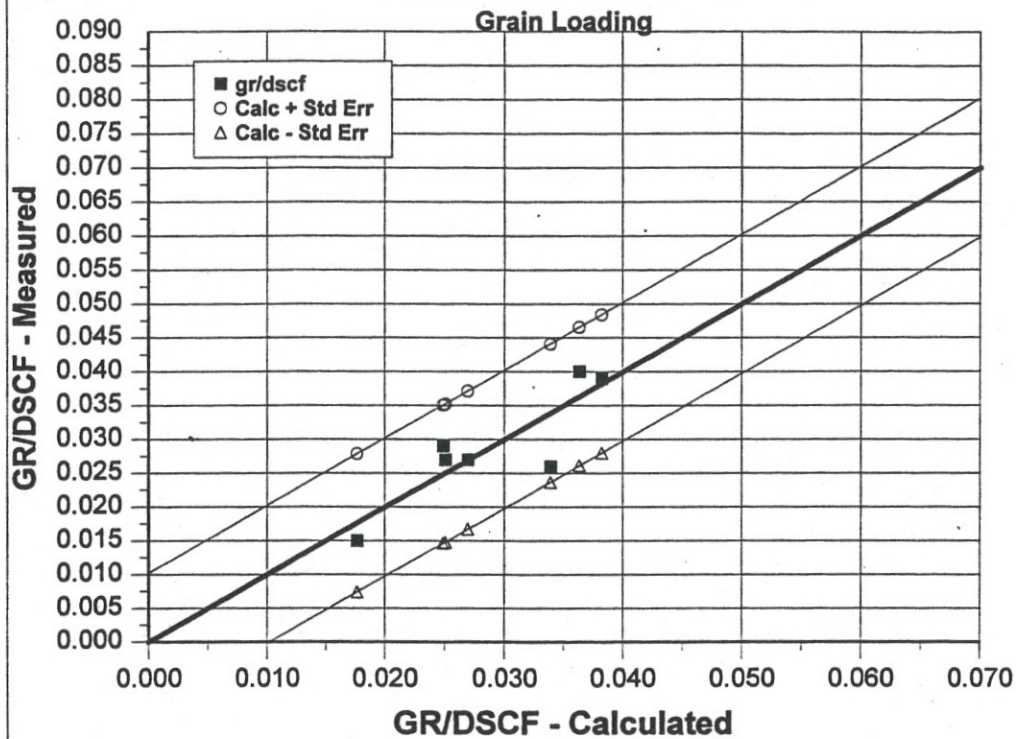
Constant	1.9664584				
Std Err of Y Est	0.0113428				
R Squared	**0.6341918**				
No. of Observations	7				
Degrees of Freedom	1				

	Pull	% Cullet	KWH/hr	CFH Gas	BW
X Coefficient(s)	0.0020275	-0.00016	-0.000087	-0.000001	-0.000792
Std Err of Coef.	0.0026635	0.0005539	0.0000847	0.0000083	0.0009665

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Seattle #4 Furnace
Particulate Emissions

Seattle #4 Furnace — Particulate Emissions — Grain Loading. Scatter plot of GR/DSCF - Measured (y-axis, 0.000 to 0.090) versus GR/DSCF - Calculated (x-axis, 0.000 to 0.070). Legend: ■ gr/dscf, ○ Calc + Std Err, △ Calc - Std Err.

(Pull * -0.00158) + (%Cullet * -0.00045) + (KWH * -0.000007) + (Gas * 0.000003) + (BW * 0.00020) + (-0.351) + (+/- 0.010) = GR/DSCF
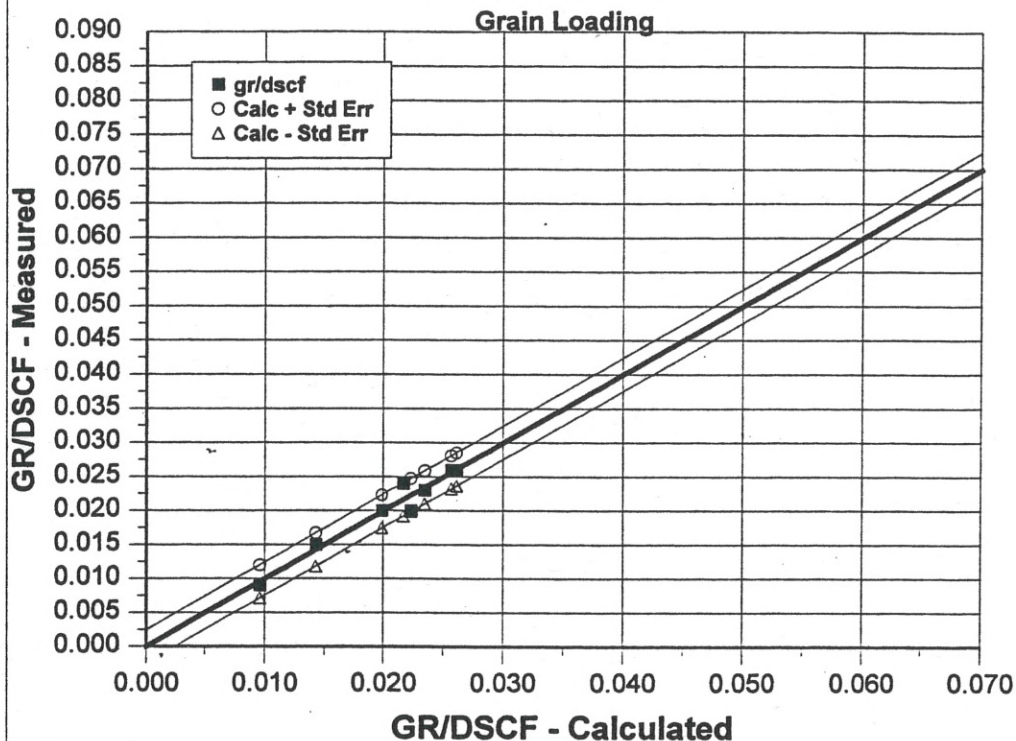
Seattle #4

Regression Output:

		Constant			-0.351331
		Std Err of Y Est			0.0102263
		R Squared			**0.7590391**
		No. of Observations			7
		Degrees of Freedom			1

	Pull	% Cullet	KWH/hr	CFH Gas	BW
X Coefficient(s)	-0.001579	-0.000448	-0.000007	0.000003	0.0002049
Std Err of Coef.	0.004026	0.0004295	0.0000074	0.0000077	0.0004181

Seattle #5 Furnace
Particulate Emissions
Grain Loading

(Pull * -0.00018) + (%Cullet * 0.00021) + (KWH * 0.000004) + (Gas * 0.000002) + (BW * -0.000005) + (0.004) + (+/- 0.002) = GR/DSCF

Seattle #5

Regression Output:

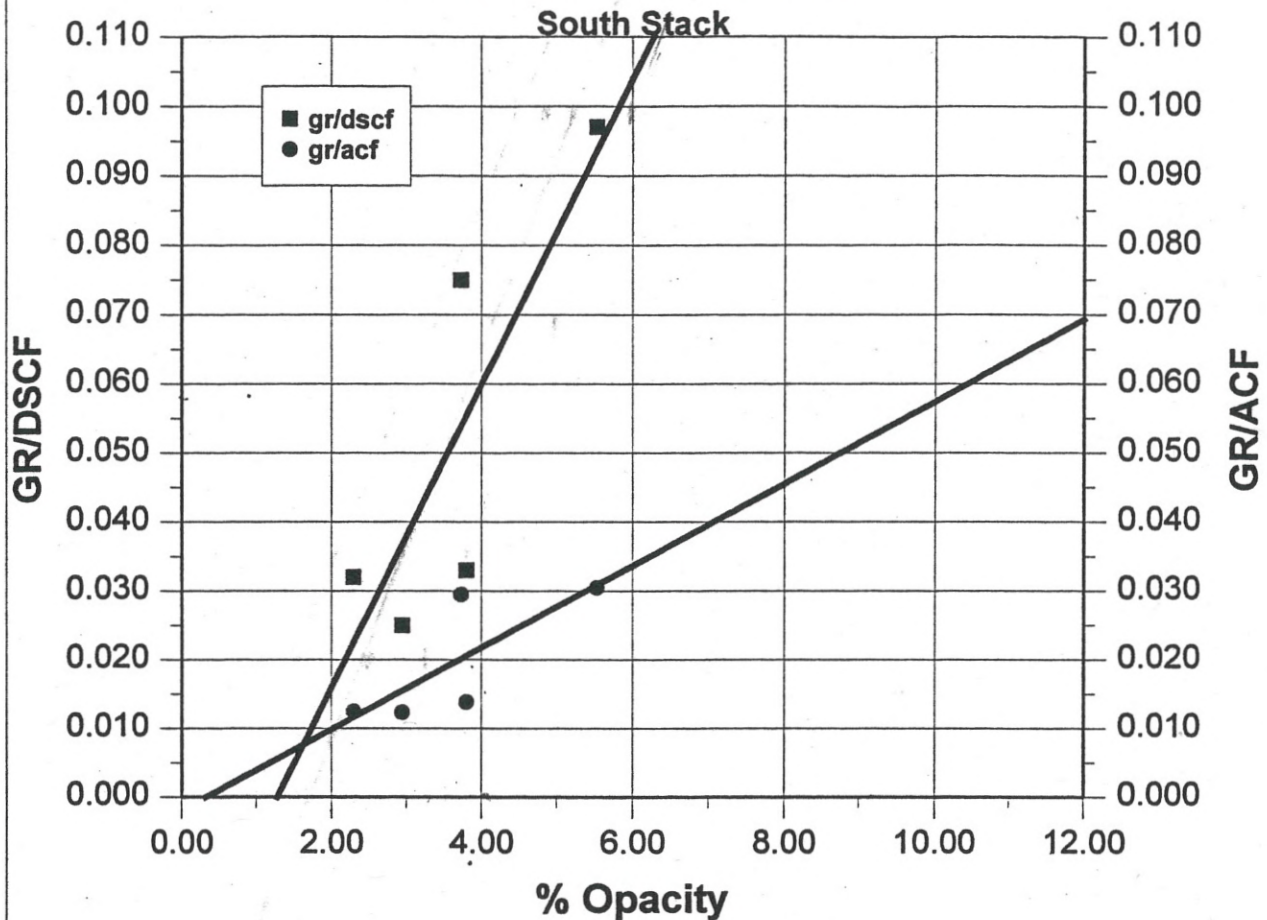|					
Constant		0.0042755			
Std Err of Y Est		0.0024452			
R Squared		**0.9505594**			
No. of Observations		8			
Degrees of Freedom		2			
	Pull	**% Cullet**	**KWH/hr**	**CFH Gas**	**BW**
X Coefficient(s)	-0.000183	0.0002134	0.0000037	0.0000023	-0.000005
Std Err of Coef.	0.000071	0.000098	0.0000021	0.0000004	0.000053

(handwritten) 38.8% 4.6% 56.8% 17.4% 1061%

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Seattle #2 Furnace
Particulate Emissions

South Stack

Legend: ■ gr/dscf ● gr/acf

Y-axis (left): GR/DSCF — 0.000 to 0.110
Y-axis (right): GR/ACF — 0.000 to 0.110
X-axis: % Opacity — 0.00 to 12.00

(X-Coefficient * Grain Loading) + Constant + (+/- Std Err) = % Opacity

Seattle #2S - gr/dscf vs % Opacity

Regression Output: −

Constant	1.9703364
Std Err of Y Est	0.76
R Squared	0.7059935
No. of Observations	5
Degrees of Freedom	3

	% Opacity
X Coefficient(s)	32.130985
Std Err of Coef.	11.971307

#2S - gr/acf vs % Opacity

Regression Output:

Constant	1.6813393
Std Err of Y Est	1
R Squared	0.5929422
No. of Observations	5
Degrees of Freedom	3

	% Opacity
X Coefficient(s)	99.84994
Std Err of Coef.	47.764915

$$\left(\frac{gr}{dsc} \times 32.130985 \right) + 1.9703364 = \% \text{ Opacity}$$

why doesn't this work
revisit Beer's law?
to understand?

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Seattle #2 Furnace
Particulate Emissions

South Stack

Legend:
- ■ gr/dscf
- ● gr/acf

Y-axis (left): GR/DSCF — 0.000 to 0.110
Y-axis (right): GR/ACF — 0.000 to 0.110
X-axis: Absorbance — 0.00 to 0.05
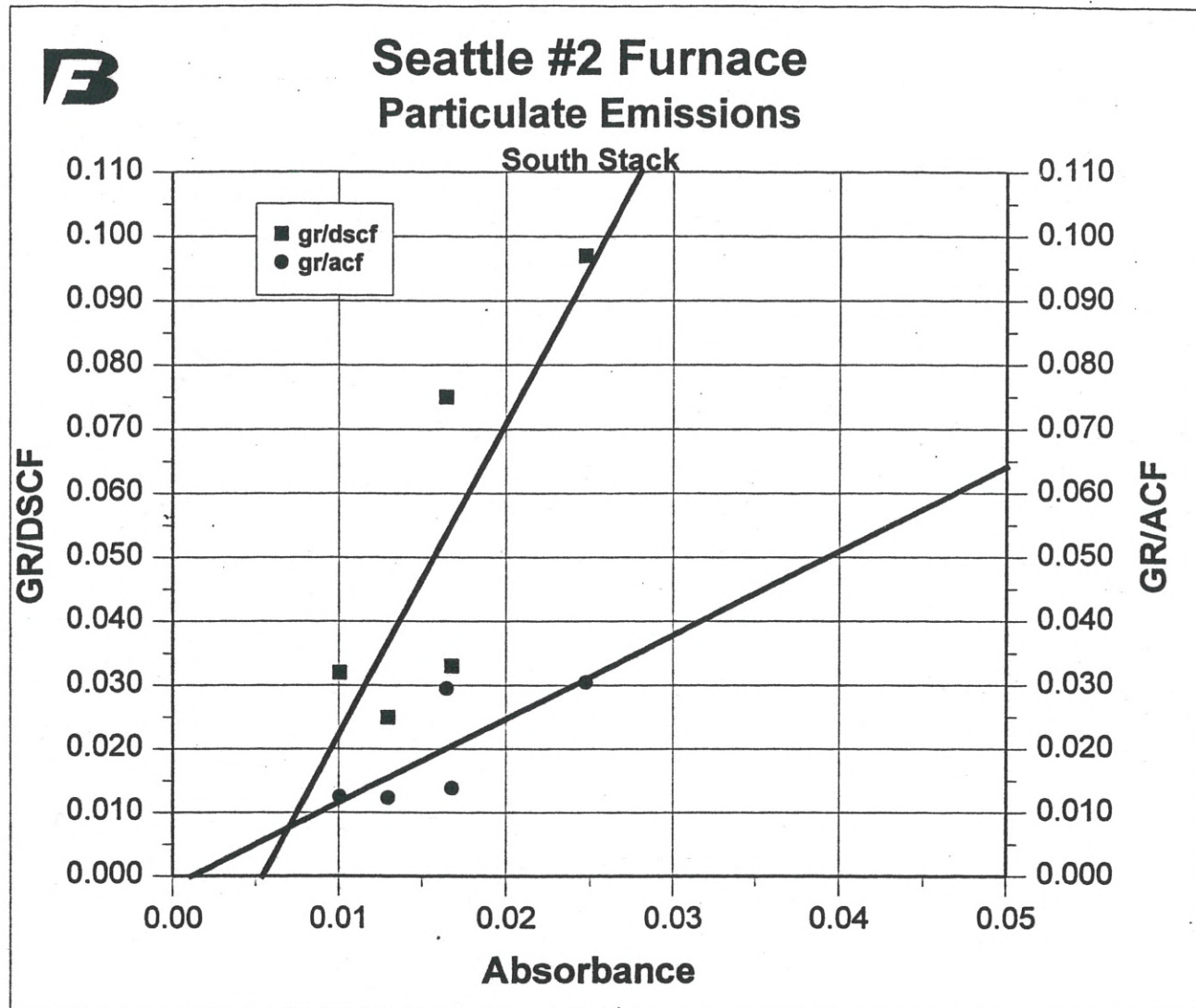
(X-Coefficient * Grain Loading) + Constant + (+/- Std Err) = Absorbance

Seattle #2S - gr/dscf vs Absorbance

Regression Output: –

Constant	0.0085722
Std Err of Y Est	0.0034352
R Squared	**0.7072892**
No. of Observations	5
Degrees of Freedom	3

	Absorbance
X Coefficient(s)	0.145456
Std Err of Coef.	0.0540247

#2S - gr/acf vs Absorbance

Regression Output:

Constant	0.0072742
Std Err of Y Est	0.0040524
R Squared	**0.5926599**
No. of Observations	5
Degrees of Freedom	3

	Absorbance
X Coefficient(s)	0.451496
Std Err of Coef.	0.2161071

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Seattle #2 Furnace
Particulate Emissions
North Stack

Legend:
■ gr/dscf
● gr/acf

Y-axis (left): GR/DSCF — 0.000 to 0.050
Y-axis (right): GR/ACF — 0.000 to 0.050
X-axis: % Opacity — 0.00 to 12.00
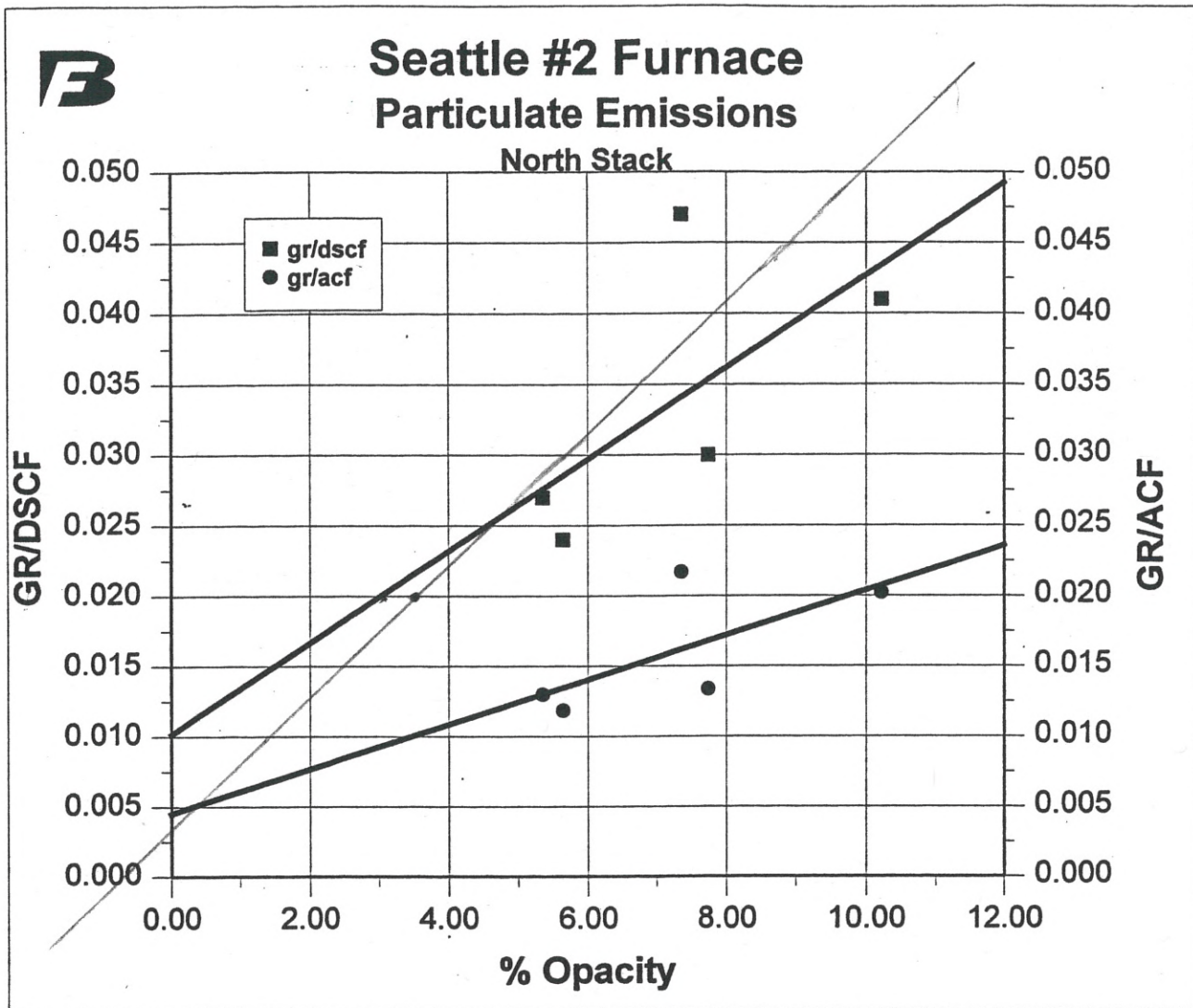
(X-Coefficient * Grain Loading) + Constant + (+/- Std Err) = % Opacity

Seattle #2N - gr/dscf vs % Opacity

Regression Output:

Constant		2.8847806
Std Err of Y Est		1.71
R Squared		0.4211028
No. of Observations		5
Degrees of Freedom		3
	% Opacity	
X Coefficient(s)	129.32602	
Std Err of Coef.	87.545113	

#2N - gr/acf vs % Opacity

Regression Output:

Constant		2.5921784
Std Err of Y Est		2
R Squared		0.4618099
No. of Observations		5
Degrees of Freedom		3
	% Opacity	
X Coefficient(s)	290.57524	
Std Err of Coef.	181.10658	

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Seattle #2 Furnace
Particulate Emissions
North Stack
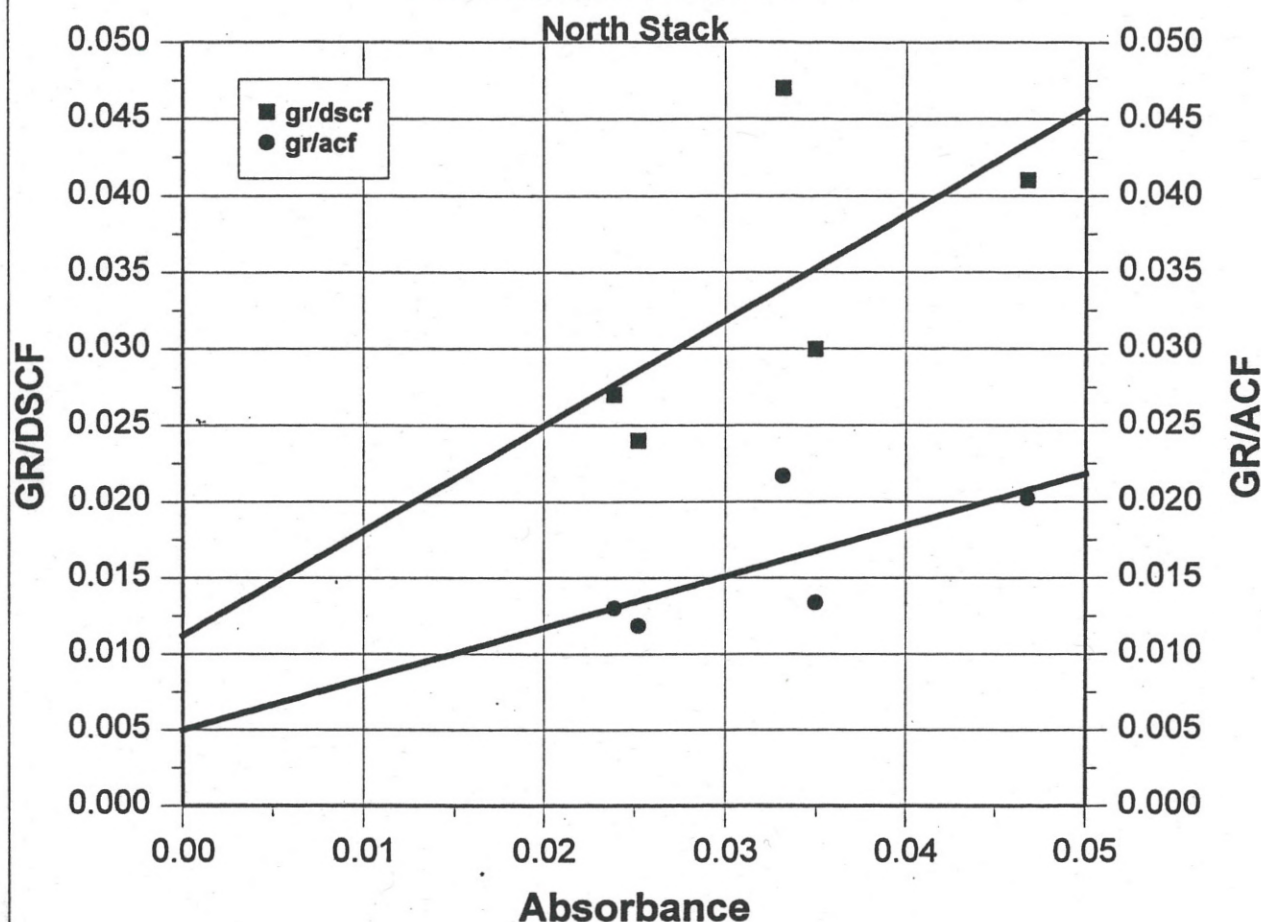
(X-Coefficient * Grain Loading) + Constant + (+/- Std Err) = Absorbance

Seattle #2N - gr/dscf vs Absorbance
Regression Output:

Constant	0.0122916
Std Err of Y Est	0.0080883
R Squared	**0.4177514**
No. of Observations	5
Degrees of Freedom	3

	Absorbance
X Coefficient(s)	0.6065071
Std Err of Coef.	0.4134001

#2N - gr/acf vs Absorbance
Regression Output:

Constant	0.0108781
Std Err of Y Est	0.0077903
R Squared	**0.4598654**
No. of Observations	5
Degrees of Freedom	3

	Absorbance
X Coefficient(s)	1.3652982
Std Err of Coef.	0.8542844

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Seattle #3 Furnace
Particulate Emissions
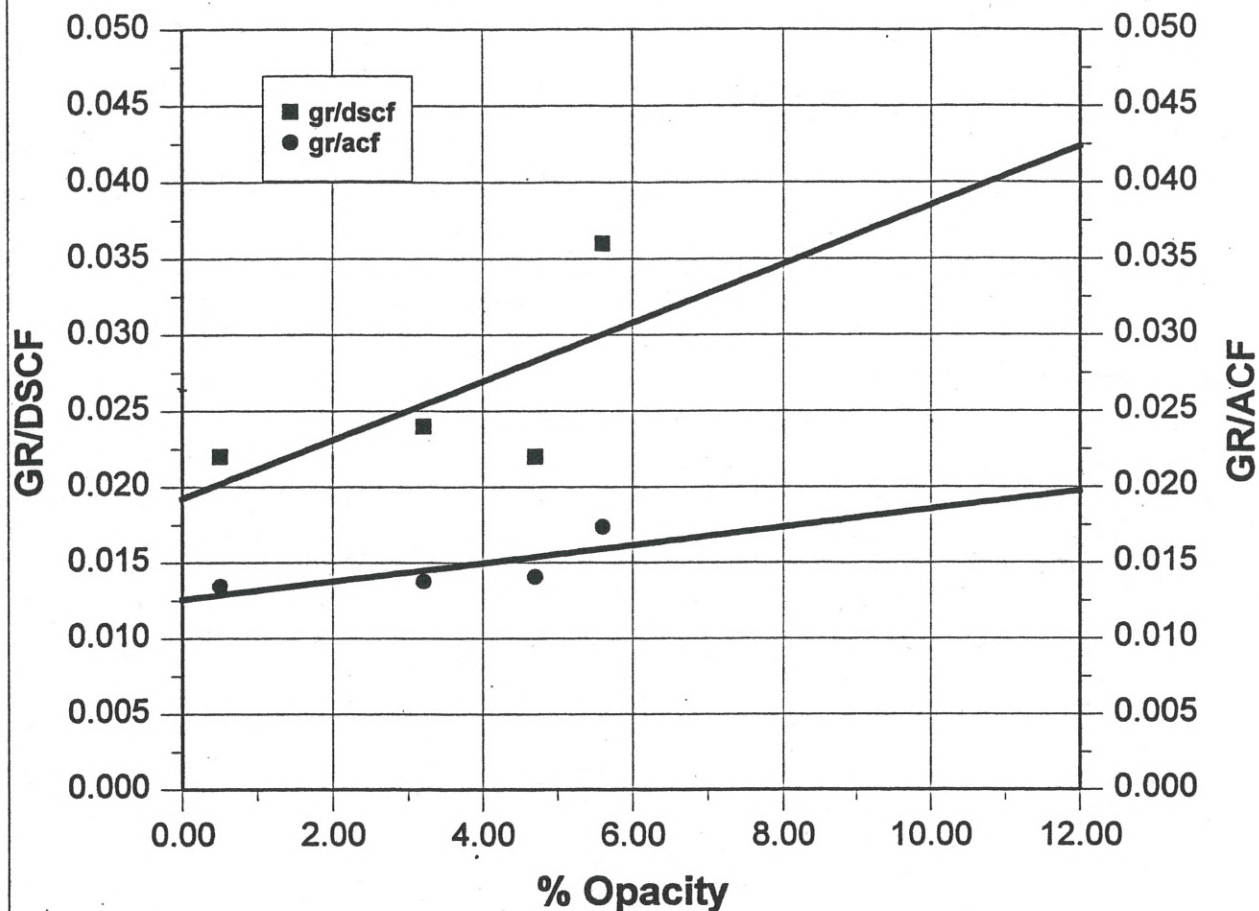
(X-Coefficient * Grain Loading) + Constant + (+/- Std Err) = % Opacity

Seattle #3 - gr/dscf vs % Opacity
Regression Output: –

Constant	-2.005882
Std Err of Y Est	2.10
R Squared	0.4082211
No. of Observations	4
Degrees of Freedom	2

	% Opacity
X Coefficient(s)	211.76471
Std Err of Coef.	180.28956

#3 - gr/acf vs % Opacity
Regression Output:

Constant	-9.698735
Std Err of Y Est	2
R Squared	0.5372862
No. of Observations	4
Degrees of Freedom	2

	% Opacity
X Coefficient(s)	898.83709
Std Err of Coef.	589.81979

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Seattle #3 Furnace
Particulate Emissions
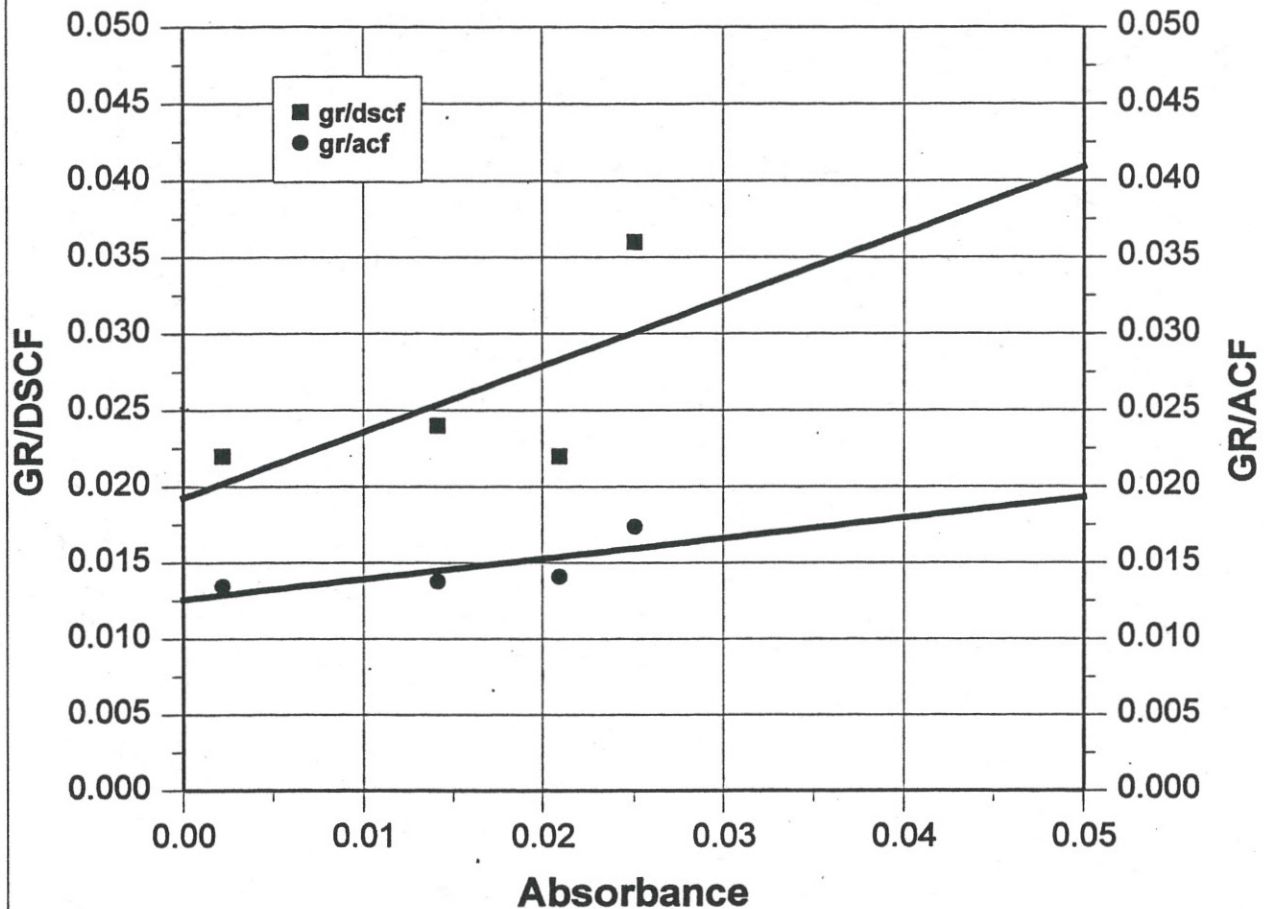
(X-Coefficient * Grain Loading) + Constant + (+/- Std Err) = Absorbance

Seattle #3 - gr/dscf vs Absorbance

Regression Output: –

Constant	-0.009235
Std Err of Y Est	0.0093734
R Squared	**0.4130963**
No. of Observations	4
Degrees of Freedom	2

	Absorbance
X Coefficient(s)	0.9536375
Std Err of Coef.	0.8037595

#3 - gr/acf vs Absorbance

Regression Output:

Constant	-0.043852
Std Err of Y Est	0.0082692
R Squared	**0.5432254**
No. of Observations	4
Degrees of Freedom	2

	Absorbance
X Coefficient(s)	4.0459452
Std Err of Coef.	2.6234086

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Seattle #4 Furnace
Particulate Emissions
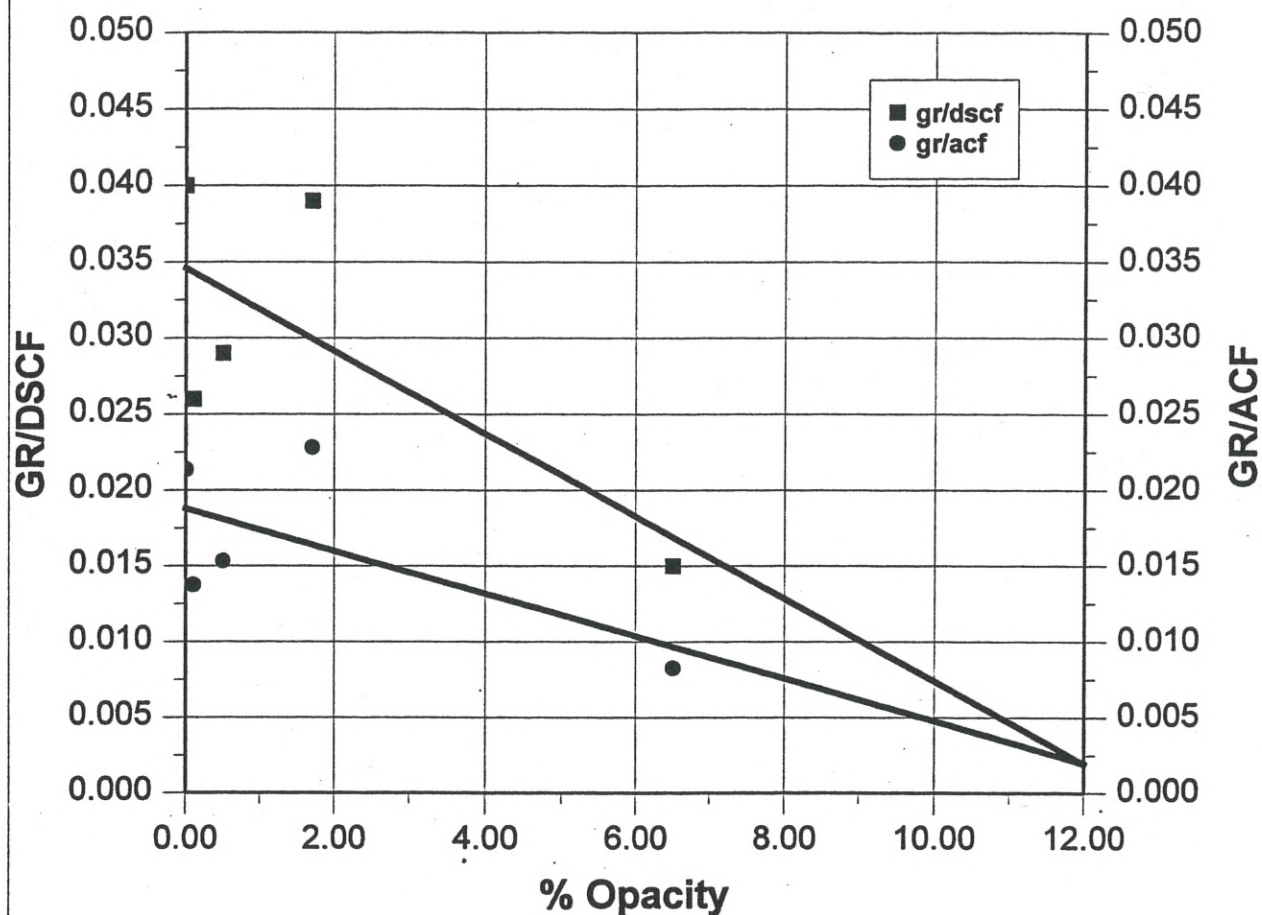
(X-Coefficient * Grain Loading) + Constant + (+/- Std Err) = % Opacity

Seattle #4 - gr/dscf vs % Opacity
Regression Output: -

Constant		7.4930464
Std Err of Y Est		2.1804798
R Squared		0.523152
No. of Observations		5
Degrees of Freedom		3
	% Opacity	
X Coefficient(s)	-192.3841	
Std Err of Coef.	106.04363	

#4 - gr/acf vs % Opacity
Regression Output:

Constant		6.6484653
Std Err of Y Est		2.4053589
R Squared		0.4197227
No. of Observations		5
Degrees of Freedom		3
	% Opacity	
X Coefficient(s)	-299.4724	
Std Err of Coef.	203.29782	

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Seattle #4 Furnace
Particulate Emissions
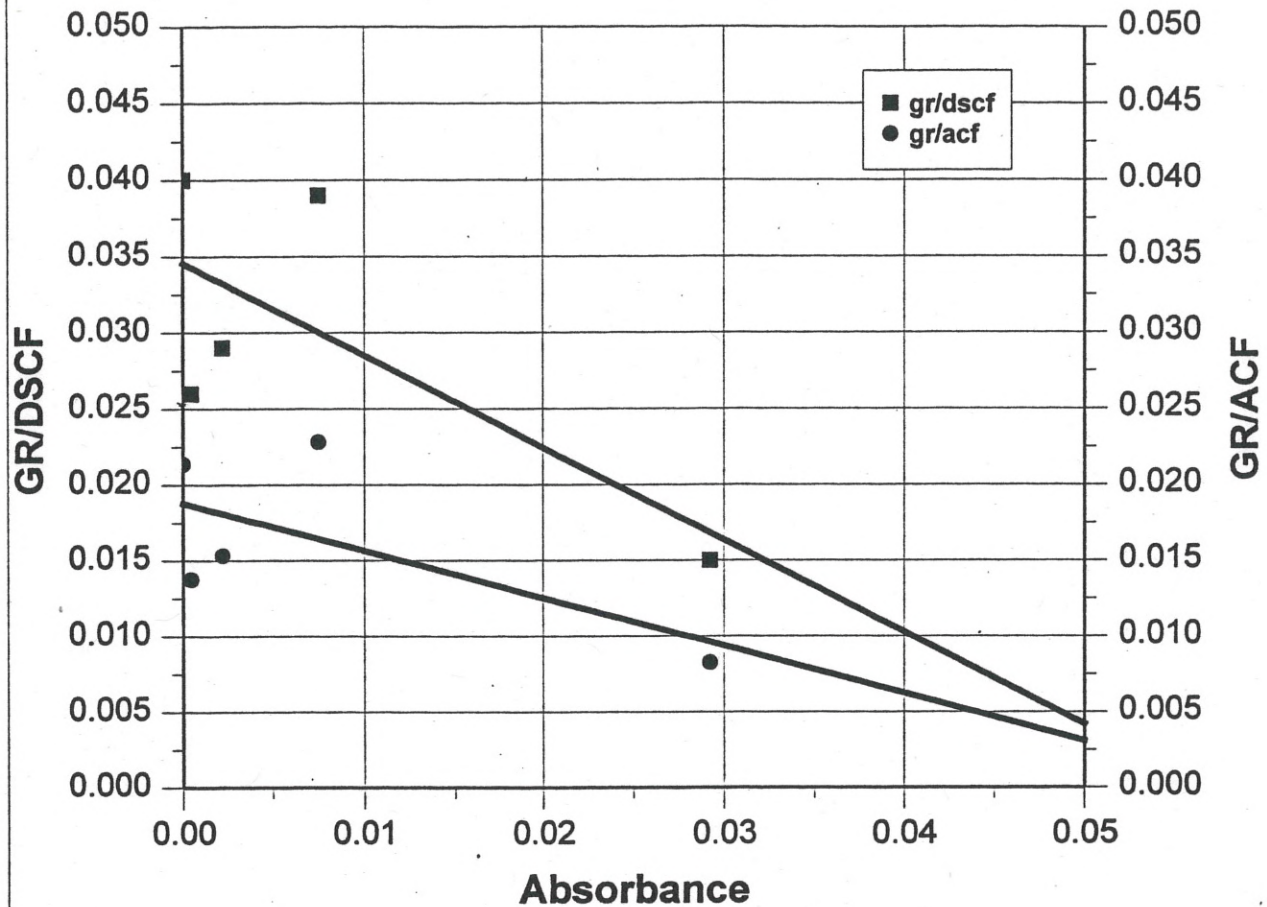
(X-Coefficient * Grain Loading) + Constant + (+/- Std Err) = Absorbance

Seattle #4 - gr/dscf vs Absorbance
Regression Output: -

Constant	0.0337074
Std Err of Y Est	0.0097629
R Squared	**0.526811**
No. of Observations	5
Degrees of Freedom	3

	Absorbance
X Coefficient(s)	-0.867723
Std Err of Coef.	0.4747995

#4 - gr/acf vs Absorbance
Regression Output:

Constant	0.0299313
Std Err of Y Est	0.010772
R Squared	**0.4239344**
No. of Observations	5
Degrees of Freedom	3

	Absorbance
X Coefficient(s)	-1.352768
Std Err of Coef.	0.9104356

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Seattle #5 Furnace
Particulate Emissions
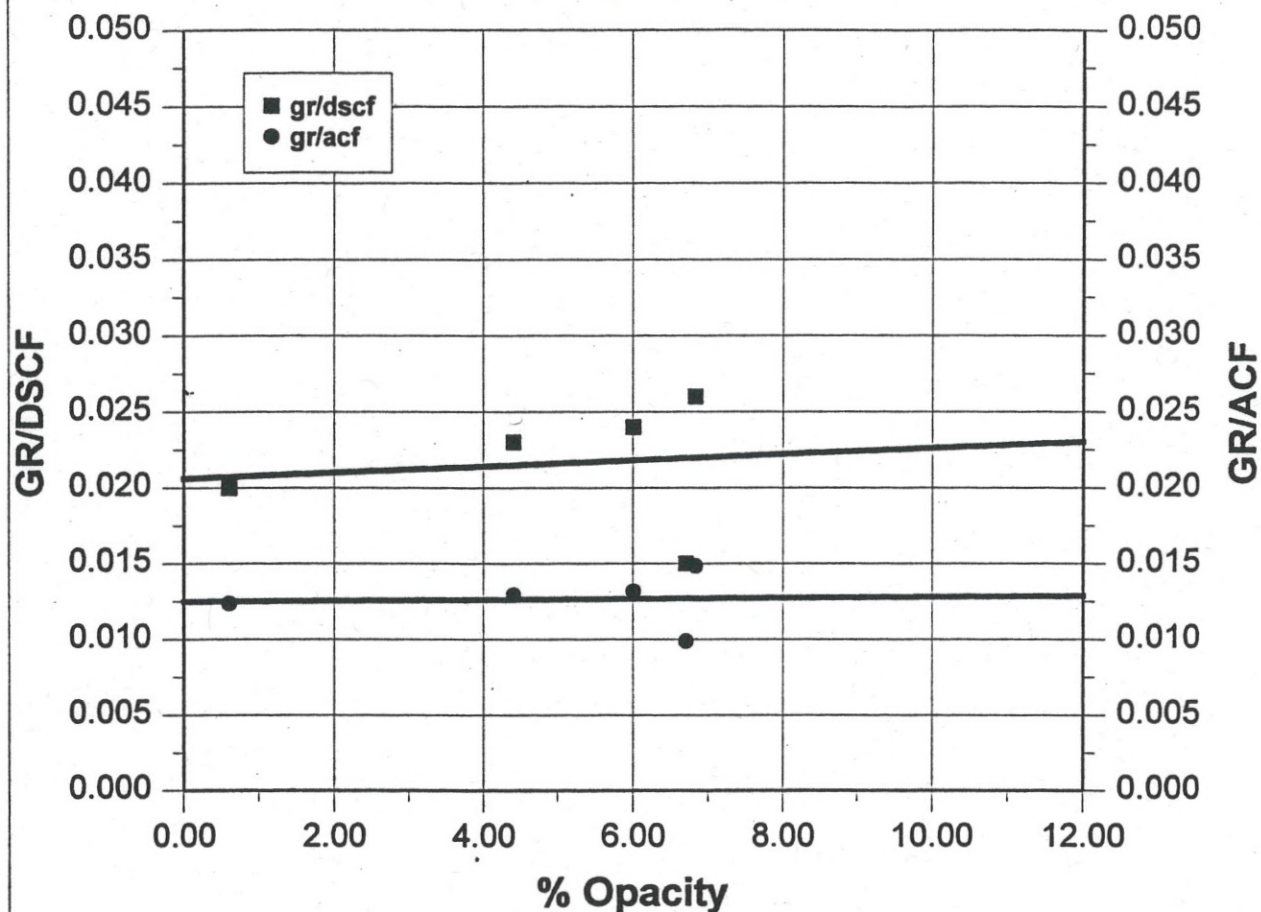
(X-Coefficient * Grain Loading) + Constant + (+/- Std Err) = % Opacity

Seattle #5 - gr/dscf vs % Opacity

Regression Output:

Constant	3.3031148
Std Err of Y Est	2.97
R Squared	0.0149768
No. of Observations	5
Degrees of Freedom	3

	% Opacity
X Coefficient(s)	74.20765
Std Err of Coef.	347.45775

#5 - gr/acf vs % Opacity

Regression Output:

Constant	4.0636846
Std Err of Y Est	3
R Squared	0.0021119
No. of Observations	5
Degrees of Freedom	3

	% Opacity
X Coefficient(s)	66.53876
Std Err of Coef.	835.05135

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Seattle #5 Furnace
Particulate Emissions
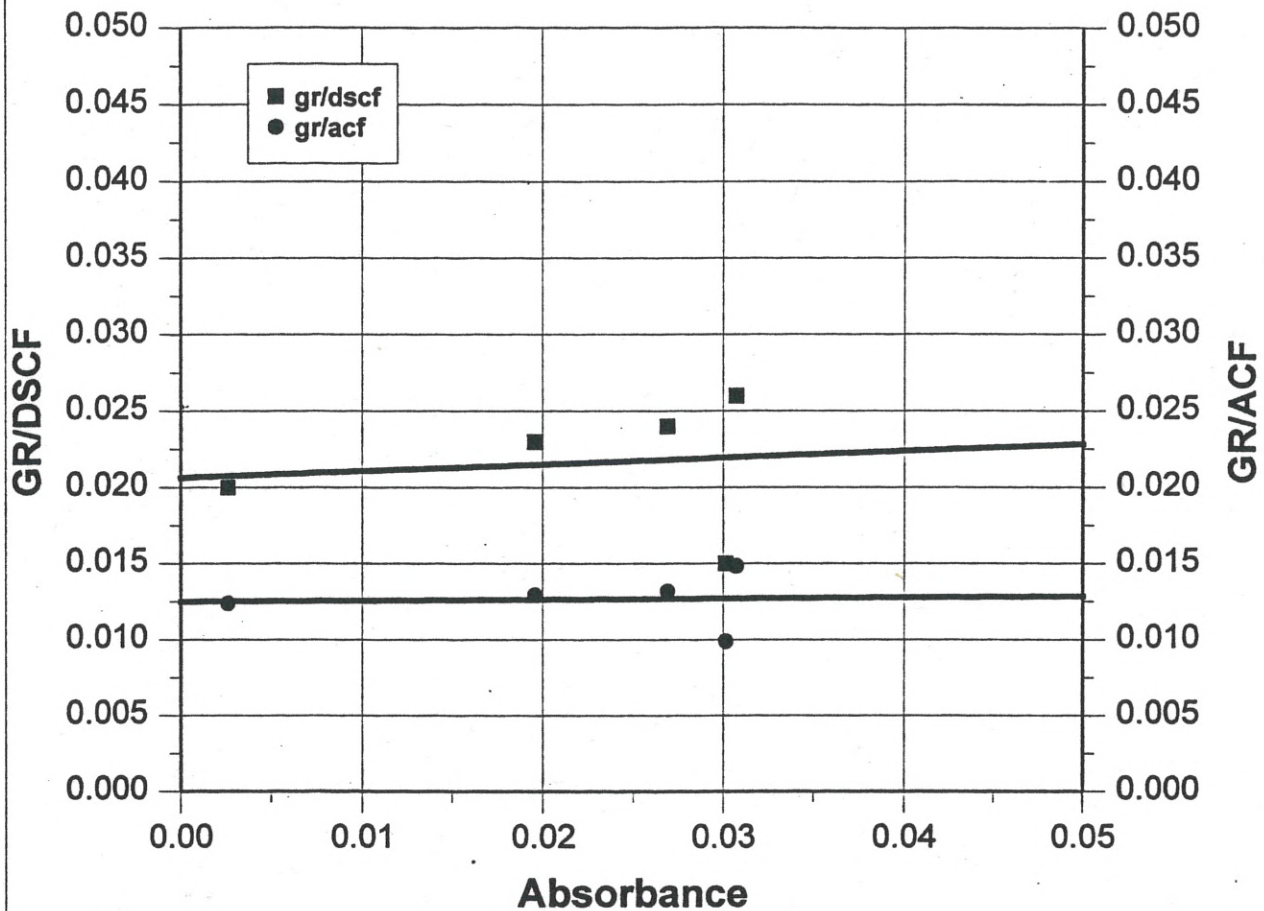
(X-Coefficient * Grain Loading) + Constant + (+/- Std Err) = Absorbance

Seattle #5 - gr/dscf vs Absorbance

Regression Output:

Constant		0.0148701
Std Err of Y Est		0.0134127
R Squared		**0.0144583**
No. of Observations		5
Degrees of Freedom		3
	Absorbance	
X Coefficient(s)	0.3288845	
Std Err of Coef.	1.5676954	

#5 - gr/acf vs Absorbance

Regression Output:

Constant		0.0182401
Std Err of Y Est		0.013497
R Squared		**0.0020398**
No. of Observations		5
Degrees of Freedom		3
	Absorbance	
X Coefficient(s)	0.2949642	
Std Err of Coef.	3.7668152	

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